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Original Research Article

A COMPARATIVE STUDY OF PULMONARY FUNCTION TESTS OF ROADSIDE VENDORS AND NORMAL HEALTHY SUBJECTS IN GWALIOR CITY

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Abstract

Background: Rapid industrial growth, globalization, and poor environmental conditions at work places have created a lot of health-related issues. The rising number of vehicles has sharply increased the level of air pollution in various cities of India. Air Pollution is now the fifth largest killer in India says newly released Findings of global Burden of Disease report. The presence of various particles and gases such as carbon dioxide, carbon monoxide, sulfur, benzene, lead, nitrogen dioxide, and nitric oxide from vehicular emission plays a vital role in the pathogenesis of respiratory diseases. There are many studies concluding that there was a considerable increased burden of respiratory morbidities and lowered lung functions in traffic policemen and petrol pump workers, indicating major burden on health facilities. Effects of pollutants on lung functions was analyzed by recording Forced Vital Capacity (FVC), forced expiratory volume in one second (FEV1) and FVC/FEV1 ratio. Authors could not find any study on roadside vendors to assess their lung functions so this study was planned to fill in the lacuna. To study the Lung Functions of roadside vendors working for more than 5yrs along roadside and compare them with normal healthy subjects who do not work in pollution exposed environment in Gwalior city. **Materials and Methods:** It is a cross-sectional comparative study done in Department of Physiology of G R Medical College, Gwalior (M.P.). We have included 90 roadside vendors and 90 age and sex matched controls in our study. According to Cambridge dictionary 'roadside vendors' are individuals who are working in shops or their temporary occupancy on edges of road. Computerized Spirometry software (MEDICAID SIPRO EXCEL) manufactured in Mohali, India, was used to assess FVC, FEV1 & FVC/FEV1 ratio. Unpaired Student t-test analysis will be done using GraphPad Prism, version 5.0 software. P-value <0.05 will be considered as significant value. **Result:** Roadside Vendors recorded a significant decline in all parameters, FVC, FEV1, and FVC/FEV1 ratio when compared with controls, and is probably due to exposure to vehicular pollution. Values of FVC (3.01L ± 0.42), FEV1 (2.57L ± 0.41), FVC/FEV1 ratio (84.94% ± 7.07), SVC (2.48 ± 0.89), MVV (72.19 ± 15.05), PEFR (4.49 ± 1.51) and FEF25-75 (3.77 ± 1.02) were significantly lower in roadside vendors than those obtained in controls, in whom the values were 4.07 ± 0.21, 3.69 ± 0.59, 89.15 ± 2.79, 4.19 ± 0.43, 124.5 ± 10.94, 9.29 ± 0.93 and 6.11 ± 0.51 for FVC, FEV1, FVC/FEV1 ratio, SVC, MVV, PEFR and FEF25-75 , p-value of all parameters is <0.05 i.e., there is significant difference in the values. **Conclusion:** In our study we found that all FVC, FEV1, FVC/FEV1 ratio, SVC, MVV, PEFR and FEF 25-75 were significantly lower in roadside vendors when compared to control groups. The effect of pollution by vehicular exhausts may be responsible for these pulmonary function impairments.

INTRODUCTION

Everyone has a particular lifestyle in which he/she lives and spends his daily time. This includes day to day behaviors, workplace environment, activities and diet.[1] According to WHO, 60% of related factors to individual health and quality of life are correlated to lifestyle.[2] Thousands of people follow an unhealthy lifestyle and thus they face its consequences in the form of illnesses, disabilities or even deaths. Problems like respiratory diseases, skeletal problems, cardiovascular diseases and so on, can be caused by an unhealthy lifestyle. Thus, we can say that to lead a healthy life one should follow a healthy lifestyle. We spend a major part of our life at our job workplace.

In recent times, rapid industrial growth, globalization and poor environmental conditions at work places have created a lot of health-related issues. The rising number of vehicles has sharply increased the level of air pollution in various cities of India.[3,4] A health survey done in 2013 by the Centre for Science and Environment (CSE), New Delhi, has shown that 141 (80%) cities in India exceeds the PM 10 (pollutants that emit particulate matter of less than 10 micrometers in size) standard, 90 cities have a critical level of PM 10 and 26 cities have the most critical level, exceedingly thrice the standards, including Gwalior. Air pollution is now the fifth largest killer in India says newly released findings of CSE report.[4]

The presence of various particles and gases such as carbon dioxide, carbon monoxide, sulfur, benzene, lead, nitrogen dioxide, and nitric oxide from vehicular emission plays a vital role in the pathogenesis of respiratory diseases.[5,6]

Evaluation of lung functions which includes measurement of Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV1), FEV1/FVC ratio, Maximum Voluntary Ventilation (MVV), Peak Expiratory Flow Rate (PEFR) is a very useful tool for assessing the effect of these pollutants over the human lungs.[7–10]

There are many studies concluding that there is a considerable increased burden of respiratory morbidities and lowered lung functions compared to the expected values among traffic policemen,[11–15] and on petrol pump workers who are exposed to the vehicular pollution indicating major burden on health facilities.[16–18]

All of above studies have discussed effects that vehicular exhaust can cause on specific group of population, still there is a significant group of population that has been unnoticed till date, that include group of individuals that continuously work along roadside to sell their goods. Similar kind of pollution exposure is also expected to occur for these "roadside vendors" who work along the roadside for their daily living. Authors could not find any research study evaluating pulmonary function tests on these roadside vendors, despite similar environmental condition and possibility of exposure to motor vehicle emissions which may affect their lung functions.

Hence, this study has been planned to fill this lacuna of information about pulmonary function tests in roadside vendors and compare the same with normal healthy subjects in Gwalior city of MP.

Objectives of the study:

1. To determine the lung functions in roadside vendors using computerized spirometry.
2. To compare lung functions of roadside vendors with normal healthy subjects

MATERIALS AND METHODS

Duration of the Study: 2 years, December 2020 to November 2022

Sample Size: Total 180, 90 Normal healthy subjects and 90 roadside vendors working along roadside for more than 5yrs.

Considering 5% level of significance and 95% power of test anticipated standard deviation of PEFR among roadside vendors and control groups 1.84 L/min and 1.80 L/min respectively with 1 L/min mean difference among both groups.[15]

Using the formula-

$$N = \frac{[S_1^2 + S_2^2] \times [Z_{\alpha/2} + Z_{1-\beta}]^2}{[X1 - X2]2}$$

S_1 – 1.84L/min

S_2 – 1.80 L/min

$Z_{\alpha/2}$ – 1.96 (At 5% level of significance)

$Z_{1-\beta}$ – 1.64 (At 95% power of test)

$X_1 - X_2 = 1$

Study design: Non-invasive Cross-sectional study

Study population: Normal healthy individuals working along roadside for more than 5 yrs, 5 days a week and at least 6 hours a day of age group 20-55 yrs.

Control population: Age and sex matched individuals not working along roadside.

- An informed consent was taken from every subject and control. Medical examination including detailed relevant medical, personal, family history was taken and filled on a separate proforma for each subject and control.
- Computerized Spirometry software (MEDICAID SIPRO EXCEL) manufactured in Mohali, India, was used to perform Lung Function Tests.
- According to Cambridge dictionary 'roadside vendors' are individuals who are working in shops or their temporary occupancy on edges of road.

Inclusion Criteria

1. **Study group:** Non-smoking roadside vendors of 20-55 yrs. of age group working for 5 days a week and at least 6 hrs a day with duration of exposure more than 5 yrs.[19]
2. **Control group:** Age and sex matched healthy subjects who are not working along the roadside.

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Exclusion Criteria

- Subjects with past or current history of Respiratory disorders including Tuberculosis, Asthma, COPD
- Subjects with history of hospitalisation for cardiovascular event
- Subjects with no personal history of smoking
- Subjects with musculoskeletal deformity
- Irregular or seasonal roadside vendors (will be excluded from cases)

Lung Function tests

Lung functions tests were done using portable Spirometer, Spiro excel machine. Computerized Spirometry software (MEDICAID SIPRO EXCEL) was used to measure Lung Functions. The logic built into the Spiro Excel evaluates the subject as an adult or child, male or female and selected the suitable set of equation for computation of predicted norms.

Technical Features Spiro Excel Machine

Flowmeter	**Bi-directional digital turbine**
Range for flow measurement	0.03 - 20 L/s
Range for volume measurement	10L
Accuracy of measurement	3% or 50ml
Dynamic resistance @ 12L/s	< 0.7 cm of H2O/L/s
Mouth pieces	31 & 21mm
Power supply	No external supply required, works on 5V from CPU
Dimensions	160 x 50 x 25 mm
Weight	100gm

The following parameters of each subject were recorded by the portable spirometer:

1. Forced vital capacity (FVC)
   - FEV1
   - FEV1/FVC
   - PEFR
2. Slow vital capacity (SVC)
3. Maximum voluntary ventilation (MVV)

Measures taken before lung function tests were performed:

1. Spirometer calibration was checked.
2. Subjects were properly explained abouts the tests to be performed by them.
3. Hand hygiene was performed before the start of the test.
4. Instructions and demonstrations were given to the subjects.

Statistical Analysis

Statistical analysis to compare the two study groups was done by student's t-test using Graph Pad Prism software.

RESULTS

In our study we found that our study group and control group are age, sex, weight and height matched, these results are shown in [Table 1]. The average duration of exposure of roadside vendors to pollution exposed workplace is 10.18 years.

General Characteristic Features:

General characteristic parameters of both the groups are summarized in [Table 2]. Average pulse of roadside vendors is 87.33 ± 5.79per min while that of control group is 76.78 ± 6.20 per min with a p-value of <0.001. Average Systolic Blood Pressure (S.B.P.) of roadside vendors is 131.3 ± 3.60 mmHg while that of control group is 125 ± 5.21 mmHg with a p-value of <0.001. All other parameters are not statistically significant.

Table 1:

S.No.	**Parameters**	**Mean ± SD**		**p-value**
		Roadside Vendors (n=90)	**Control Group (n=90)**	
01	Age (years)	36.31 ± 5.26	38.14 ± 4.5	0.11
02	Height (cm)	161.7 ± 4.59	162.7 ± 4.19	0.14
03	Weight (Kg)	64.02 ± 3.37	64.81 ± 4.01	0.15

Table 2: General Characteristic Parameters of Roadside Vendors and Control Group

S.No.	**Parameters**	**Mean ± SD**		**p-value**
		Roadside Vendors (n=90)	**Control Group (n =90)**	
01	Pulse (per min)	87.33 ± 5.79	76.78 ± 6.20	<0.001*
02	S.B.P (mmHg)	131.3 ± 3.60	125 ± 5.21	<0.001*
03	D.B.P. (mmHg)	83.67 ± 4.44	83.64 ± 3.99	0.97
04	Respiratory Rate (per min)	18.33 ± 1.85	18.38 ± 1.89	0.87

Spirometry Findings

Spirometry findings are summarized in [Table 3].

Table 3: Forced Vital Capacity, Slow Vital Capacity & Maximum Voluntary Ventilation of Roadside Vendors and Control Group

S.No.	**Parameter**	**Mean ± SD**		**p-value**
		Roadside Vendors (n=90)	**Control Group (n=90)**	
01	FVC (L)	3.01 ± 0.42	4.07 ± 0.21	<0.001*
02	SVC (L)	2.48 ± 0.89	4.19 ± 0.43	<0.001*
03	FEV1 (L)	2.57 ± 0.41	3.69 ± 0.59	<0.001*
04	FEV1/FVC (%)	84.94 ± 7.07	89.15 ± 2.79	<0.001*
05	MVV (L/min)	72.19 ± 15.05	124.5 ± 10.94	<0.001*
06	PEFR (L/s)	4.49 ± 1.51	9.29 ± 0.93	<0.001*
07	FEF 25-75 L/s	3.77 ± 1.02	6.11 ± 0.51	<0.001*

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All spirometry parameters showed significant difference between two study groups in which roadside vendors showed significantly lower values when compared to control group.

DISCUSSION

Nature always maintains a balance between land, water, air and all living organisms in world. If left on its own, nature will thrive fruitfully this was also seen during covid lockdowns when all industries and vehicles came to halt nature healed almost all rivers and air quality towards normal. Humans due to their rapid evolution have created serious imbalance in nature's ecosystem and this has started to affects their own health in a negative way.

Rapid industrialization, urbanization, use of vehicles are the major causes of environmental pollution in the world. Experimental studies indicate that due to airborne contaminants of diesel fumes, changes in PFTs are seen due to injury to airways and parenchyma in subjects who are exposed to it, because lungs are the major site of contact between the body and the environment, they are one of the first organ to be affected in our body.

The population of roadside vendors is susceptible for air pollution exposure as most of the time they are busy on the roads and are exposed to automobile exhaust and other air pollutants. Exposure to air pollutants over a long period is said to have deleterious effects on the respiratory functions of roadside vendors.

In our present study estimation of various lung parameters like FVC, FEV1, FEV1/FVC, FEF 25-75%, PEF and SVC were done using digital Medicaid Spiro-excel spirometer among roadside vendors of age 20-55 years who were non-smokers and these parameters were compared with age and sex matched normal healthy population who were not the road side vendors (Control Group). Further, we tried to calculate correlation of these parameters with the duration of their job among roadside vendors.

No significant difference was observed in anthropometric parameters like weight and height of roadside vendors and control group of the study [Table 1].

FVC, SVC & MVV:

We observed that all capacities of lung i.e., FVC, SVC and MVV of roadside vendors is significantly lower than that of control group. We found that Percentage Predicted FVC of roadside vendors is 76.76%±10.62 which is indicating a restrictive pattern of lung pathology in roadside vendors, whereas control group had Percentage Predicted of FVC of 98.5%±8.65, this difference is statistically highly significant with a p-value of <0.001.

Similar results were also seen in a study conducted in Pune city by Gavali et al. (2012) which showed reduction in FVC functions in auto drivers which depicted restrictive type of lung impairment when compared to control group.[20]

Vehicular exhaust particles have size < 0.1 micrometer by releasing reactive oxygen species produces inflammation in the lungs and affects its function. Diesel exhaust particulate constitutes a large proportion of the PM in ambient air. In particular, diesel exhaust fumes cause bronchoconstriction, neutrophilic inflammation and dysfunction of alveolar phagocytosis together with histamine release from mast cell in healthy individuals.

Human lung parenchyma retains PM of <2.5 (so these are also called "Respiratory PM"). PM is a highly toxic material because of its small size chemical composition, as suggested by the influx of inflammatory leukocytes into the airspace. PM has a variety of effect on lung defenses. Transition metals contained in PM, particularly iron, damage the airways by generating free radicals and stress.[21] Important cells involved in the initial inflammatory responses to foreign particles are the macrophages and induces oxidative stress in these cells. Therefore, chronic exposure to these particles can lead to inflammation of respiratory tract and lung parenchyma. Thus, it can contribute to substantial decrease in lung functions.[21]

FEV1:

We observed that FEV1 of roadside vendors to be significantly lower when compared to control group, with a mean value of 2.57 L ± 0.41 and 3.69 L ± 0.59 respectively, and this difference is statistically highly significant with a p-value of <0.001.

Similar results were found in a study done by Nair GB et al (2014) in petrol pump workers in Kerala who compared FEV1 of these petrol pump workers with normal healthy individuals as control group they found that FEV1 was significantly lower in petrol pump workers when compared to control group.[22]

FEV1/FVC ratio:

We observed that FEV1/FVC ratio in roadside vendors is 84.94% ± 7.07 whereas of control group is 89.15% ± 2.79 this shows that FEV1/FVC ratio is significantly lower in roadside vendors when compared to control group with a p-value of <0.001, however both sets of results are within normal range i.e., if FEV1/FVC ratio is considered to be normal if the value is above 80% and thus our both case and controls have normal FEV1/FVC ratio.[23]

We observed that, percentage predicted of FEV1/FVC ratio of roadside vendors and control group were 106.4% ± 8.67 and 111% ± 3.79 respectively, by this observation we can see that that there is no obstruction in flow of air in both sets of our study population.

Similar results were seen in a study done by Pakkala et al (2013) in Chittoor district who compared lung functions of pollution exposed sportspersons and control groups. They found FEV1/FVC ratio significantly lower in sportspersons, where pollution exposed sports person has FEV1/FVC ratio of 76%.[24]

A study was done by Raina V et al. (2014) who compared pulmonary function tests in traffic police

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personnel and normal control groups in Jammu region. In their study they did not find any significant decline in FEV1/FVC in traffic police personnel when compared to control group, however in their study FVC, FEV1, PEFR was found to be statistically significantly reduced in traffic police personnel.[25]

PEFR:

We observed that there is significant difference in PEFR of roadside vendors and control group where roadside vendors have PEFR of 4.49 L/s ± 1.51 and control group have PEFR of 9.29 L/s ± 0.93. On comparing Percentage Predicted of PEFR of roadside vendors and control group percentage predicted of PEFR of roadside vendors is 54% ± 17.56 whereas that of control group is 107.5% ± 11.72, and this difference is statistically significant. Decreased PEFR means that peak flow rate is reduced of airflow.

FEF 25-75%:

FEF 25-75% of roadside vendors is 3.77 L/s ± 1.02 while that of control group is 6.11 L/s ± 0.51 and this difference is statistically significant where roadside vendors have significantly lower FEF25-75%.

Similar results were seen in a study done by Binawara BK et al. (2010) who compared pulmonary function tests of taxi drivers with normal control group. They found that FVC, PEFR and FEF25-75% all were significantly lower in taxi drivers when compared to control group.[26]

Along with particulate matter pollutants, SO2 and NO2 have a greater chance to reach the deeper parts of the lungs. The properties and concentration of surfactant are altered by these gaseous pollutants and may thus contribute to the early closure of smaller airways. Most of the terminal bronchioles may be compromised before other pulmonary function tests such as FEV1 are affected. Histopathological studies have showed evidence that the smaller airways are the major site of damage in persons living in areas of high air pollution. Diesel exhaust generates particles are extremely small which is of size 0.02-0.2 nanometer. These small sized particles with their greater surface area can carry much larger fraction of hydrocarbons and metals on their surface which are toxic compounds. Moreover, they remain in the air for the longer period of time and they also get deposited in lungs in greater amounts than larger sized particles.[21]

CONCLUSION

Pulmonary function parameters of 90 non-smoking roadside vendors who were working for more than 5 years were compared with age matched 90 healthy controls.

From the present study it was concluded:

- The Roadside vendors were having a significantly reduced respiratory parameters like FVC, FEV1, FEV1/FVC, PEFR, FEF25-75%, SVC and MVV when compared with control groups whose age, weight and height are matched.
- There was significant difference in the above values depicting the restrictive type pattern of lung functions alone in roadside vendors who are working for less than 10 years.
- In roadside vendors who are working for more than 10 years obstructive pattern of lung function was also observed along with restrictive lung function.
- Also, it was observed that roadside vendors who were working for more than 10 years have their respiratory function parameter FVC, FEV1, FEV1/FVC ratio, PEFR and FEF 25-75% affected more when compared with those who were working less than 10 years.

To the best of our knowledge this is the first study of its kind in which roadside vendors have been evaluated for pulmonary function tests. There are many studies that have evaluated pulmonary function tests on traffic police personnel, auto rickshaw drivers & taxi/bus drivers but no one has evaluated the effect of the automobile exhaust/pollution on roadside vendors.

Hence this study proves that the effect of traffic pollution is not only over any specified group of population but on all the possible groups that are exposed to traffic pollution like roadside vendors.

The effects of traffic pollution are almost similar as observed in previous studies conducted on other groups of population i.e., restrictive type of lung impairment for low duration of exposure to traffic pollution which is then superimposed with obstructive pattern of pathology on prolonged exposure.

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