ORIGINAL RESEARCH

Study of lung function in children residing in puffed rice industrial area

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ABSTRACT
Aim: To study of lung function in children residing in puffed rice industrial area. **Material and methods:** This cross sectional study was done in the puffed rice industrial area of Basha nagar area of Davanagere city. Lung function was recorded with the use of a spirometer (RMS Helios 401). Spirometry was conducted according to the recommendations of the American Thoracic Society. Forced expiratory volume 1 (FEV1) will be measured first and proceeded only if FEV1 IS > 80%. FEV1, forced vital capacity (FVC), forced expiratory flow between 25 and 75 percent of the FVC (FEF25–75) and the FEV1:FVC ratio was used as the primary variables of lung function **Results**: only a very small number of subjects had decreased FVC, FEV1 and FEV1/FVC. Majority of children had normal values for theses parameters, even though with wide range of values. When PFT parameters were compared between two groups with BMI <18.5 and ≥18.5 kg/m^2 , there were no statistical significant differences in any of the parameters. Based on pulmonary function test results, 5.7% of children with presence of AM carbon had moderate obstructive airway disease; the prevalence was 5% in those without AM carbon. There was so statistical difference between these groups (p >0.05). Of children with presence of AM carbon, 20.7% had restrictive airway disease; the prevalence was 24.6 % in those without presence of AM carbon. No statistical difference found between these two groups. **Conclusion**: In this cross-sectional study, we found a dose-dependent, inverse association between the carbon content of airway macrophages and FEV1, and FVC in healthy children. Since we directly assessed the carbon content of airway macrophages, our data strengthen the evidence for a causal association between the inhalation of carbonaceous particles and impaired lung function in children.

Keywords: lung, airway macrophages, children

INTRODUCTION

The air quality of outdoor spaces, particularly in metropolitan areas, has seen a notable deterioration as a consequence of urbanisation and the fast rise of a variety of businesses. This has developed into a significant problem for people's health not just in large cities but also in smaller communities and villages. Pollution of outdoor air has led to a large rise in the occurrence of a variety of respiratory illnesses in both children and adults. These conditions have a detrimental impact on the expansion and maturation of youngsters.[1-3] The incidence of allergic respiratory diseases and bronchial asthma appears to be increasing worldwide. Outdoor pollution due to industries is one of the causes for increased morbidity by causing chronic respiratory illnesses among both children and adults. Air pollution can injure the airway mucous membranes and impair mucociliary clearance which in turn may facilitate access of inhaled allergens to the cells of the immune system, thus promoting sensitization of the airway [1]. Consequently, a more severe immunoglobulin (IgE) mediated response to aeroallergens and airway inflammation could account for increasing prevalence of allergic respiratory diseases in polluted urban areas. [2]

Damage to the respiratory system in children can be devastating and permanent and the adverse effects of air pollution may be obvious in adult life owing to the long latent periods for several chronic diseases. Some children are more susceptible than others. Individuals with underlying chronic lung disease are at a greater risk than those not having such conditions. Furthermore, pattern and magnitude of exposure to indoor air pollution vary among children; those receiving higher exposures indoor for example from parental smoking and cooking fuel emissions are at greater risk of being affected by outdoor pollutants.[4-7]

Recently there have been efforts made by the Government authorities to replace the existing conventional stoves at mandakki bhattis (puffed rice factories) with modernized and environmental friendly "wood-fired gasifier oven in Davangere city. This study aims to study the carbon content of airway macrophages and lung functions in children residing in these industrial areas.

MATERIAL AND METHODS

This cross sectional study was done in the puffed rice industrial area of Basha nagar area of Davanagere city. For comparison, nonindustrial areas was selected. Healthy children between 8 and 15 years residing in puffed rice industrial area for at least 1 year before onset of the study who have normal activity level as reported by their parents. For comparison, children of similar age group residing in nonindustrial areas were studied. Ethical permission for the study was obtained from Institutional Ethical Review Board (IERB).

Inclusion criteria: Children

- >8 years of age.
- <15 year of age.
- Residing in same house for at least 1 year.

Exclusion criteria: Children

- With any chronic respiratory condition.
- With symptoms consistent with a respiratory infection over the previous three months.
- With passive exposure to tobacco smoke at home.
- With post-bronchodilator forced expiratory volume in one second (FEV1) of less than 80% of the predicted value.

METHODOLOGY

SPUTUM COLLECTION

Children were pre-treated with 200 µg salbutamol nebulization for five minutes and 5% saline nebulization for 15 minutes. Then, they were asked to cough out at least 2 mL of sputum in a wide mouthed clean container.

LUNG FUNCTION

Lung function was recorded with the use of a spirometer (RMS Helios 401). This system was compliant with the recommendations of the American Thoracic Society and the European Respiratory Society for lung function in children. Spirometry was conducted according to the recommendations of the American Thoracic Society. Forced expiratory volume 1 (FEV1) was measured first and proceeded only if FEV1 IS > 80%. FEV1, forced vital capacity (FVC), forced expiratory flow between 25 and 75 percent of the FVC (FEF25–75) and the FEV1:FVC ratio was used as the primary variables of lung function.

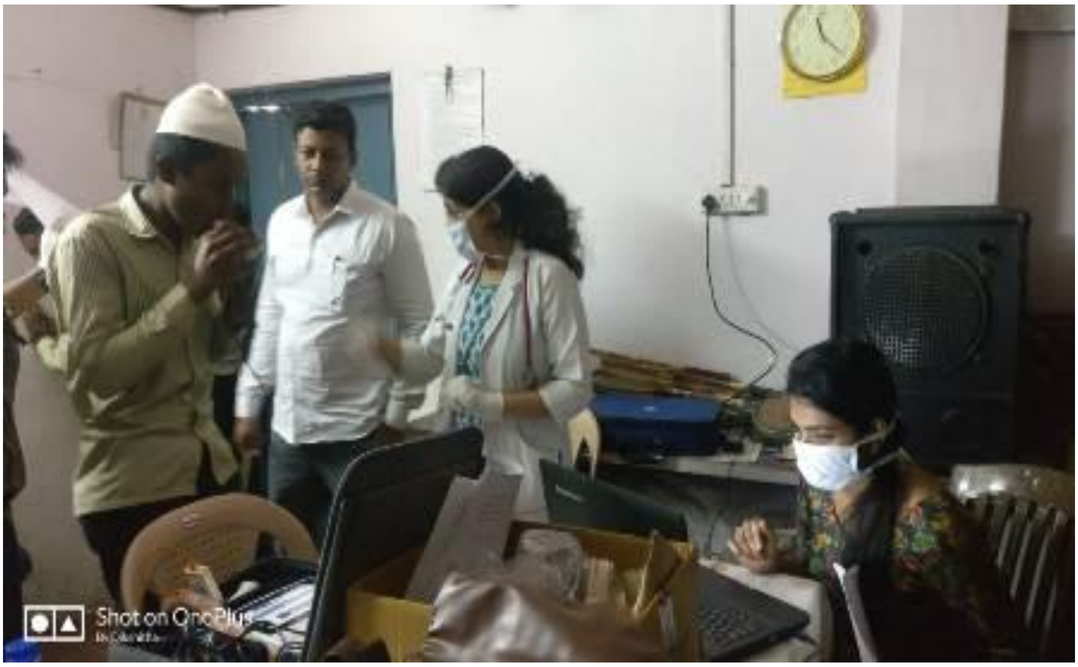

Figure 1. Lung function assessment by spirometry

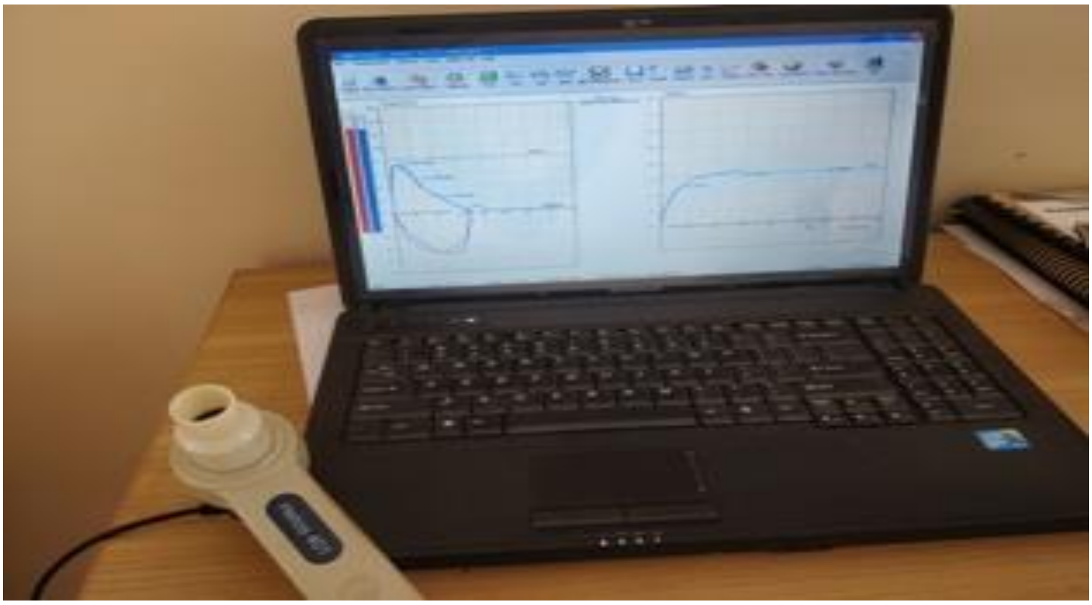

Figure 2. Spirometer [RMS Helios 401] used for lung function estimation.

RESULTS

Table 1. Demographic characteristics of study children

Variables	Mean	Std. Deviation
Age (Yrs)	13.92	.817
Duration of stay in study area (yrs)	6.94	3.085
Duration of stay at home (hrs)	13.83	1.555
Height (Meter)	1.58	0.716
Weight (Kg)	43.53	8.675
BMI (Kg/M^2)	18.05	3.087
Mid arm circumference(cm)	22.39	2.363

The mean age of study population was 13.92 (SD ± 0.817) yrs. Mean duration of stay in study area was 6.94 yrs. Mean BMI was 18.05 Kg/M^2 which is normal according to recommended values for Asian population. Baseline characteristics between boys and girls were similar.

Table 2. Pulmonary function test of study population

Variables (% predicted)	Mean	Std. Deviation	Range
FVC	97.10	26.747	68- 235
FEV1	101.70	25.709	50-229
FEV1/FVC	110.80	12.322	56-153
FEF 25-75	85.88	28.178	37- 190

Pulmonary function test values showed wide range of all three parameters assessed. However only very few subjects had abnormal values. Mean of all parameters are normal as per age , sex. We compared PFT between those who did not had AM carbon and those who had AM carbon.

Table 3. Number of children stratified by PFT

FVC (% Predicted)	Frequency	Percent
> 80	307	76.8
60-80	93	23.3
FEV1 (% Predicted)		
< 60	1	.3
>80	382	95.5
60-80	17	4.3
FEV1/FVC (% Predicted)		
≥ 88	379	94.8
< 70	1	.3
70-87	20	5.0

This table reveals that only a very small number of subjects had decreased FVC, FEV1 and FEV1/FVC. Majority of children had normal values for theses parameters, even though with wide range of values.

As per Asian guidelines recommended for BMI classification, 57% subjects were underweight, 37% of subjects were of normal weight and around 3% each were overweight and obese. when PFT parameters were compared between subjects with low and normal BMI, there was no significant difference between groups.

Table 4. Comparison of PFT between subjects with BMI <18.5 and BMI ≥ 18.5

	BMI (Kg/m^2)	N	Mean	Std. Dev	p value
FVC	<18.5	228	96.01	23.38	0.1
	≥18.5	172	93.27	17.50	
FEV1	<18.5	228	102.38	2.19	0.3
	≥18.5	172	100.18	17.95	
FEV1/FVC	<18.5	228	108.52	15.8	0.6
	≥18.5	172	112.23	10.08	
FEF 25-75	<18.5	228	86.45	25.61	0.8
	≥18.5	172	85.84	26.45	

When PFT parameters were compared between two groups with BMI <18.5 and ≥18.5 kg/m^2 , there were no statistical significant differences in any of the parameters.

Table 5. Number (%) of children stratified by pulmonary function test results and living areas

Parameter	Severity	AM carbon present N (%)	AM carbon Absent N(%)
FVC (% Predicted)	> 80	111 (79.2)	196 (75.3)
	60-80	29 (20.7)	64 (24.6)
FEV1 (% Predicted)	> 80	130 (92.8)	252 (98.84
	60-80	9 (6.4)	8 (3.07)
	<60	1 (0.7)	0 (0)
FEV1/FVC(% Predicted)	≥ 88	132(94.2)	247 (95)
	< 70	0 (0)	0 (0)
	70-87	8 (5.7)	13 (5)

Based on pulmonary function test results, 5.7% of children with presence of AM carbon had moderate obstructive airway disease; the prevalence was 5% in those without AM carbon. There was so statistical difference between these groups (p >0.05) . Of children with presence of AM carbon, 20.7% had restrictive airway disease; the prevalence was 24.6 % in those without presence of AM carbon. No statistical difference found between these two groups.

DISCUSSION

In developed countries, modernization has been accompanied by a shift from biomass fuels such as wood to petroleum products and electricity. In developing countries, however, even where cleaner and more sophisticated fuels are available, the small scale industries often continue to use simple biomass fuels. Poverty is one of the main barriers to the adoption of cleaner fuels. The slow pace of development in India suggests that biomass fuels will continue to be used by the poor for many decades. Biomass fuel is any material derived from plants or animals which is deliberately burnt by humans. Wood is the most common example, but the use of animal dung and crop residues is also widespread.[8,9]

The results of this study showed that there is association between airway macrophage carbon content and pulmonary function test. AM carbon is considered as surrogate marker of long term exposure to both outdoor and indoor air pollution. Other various factors like age, gender, BMI, height, weight, mid arm circumference did not correlate with AM carbon content and lung function.

The most recent cross-sectional analysis of the cohort of 12 Southern California communities showed that a greater proportion of young adults with an FEV1 of less than 80 percent of the predicted value than of those with a higher FEV1 live in communities with high levels of elemental carbon and PM10 [10]. Similarly, in their three-year study of eight European communities, Horak et al [11]. found reduced growth of FEV1 and FEF25–75 in children exposed to high levels of PM10 in summer. In our study we did not have data regarding outdoor levels of particulate matter. However many studies have shown that airway macrophage carbon content is a good surrogate marker of long term exposure to air pollutants, both outdoor as well as indoor. In our study 5.7% of children with presence of AM carbon had moderate obstructive airway disease and 20.7% had restrictive airway disease.

Several other factors apart from outdoor air pollution also affect deposition of carbon particles in airways. Such confounding factors like exposure to passive smoking, residence near to major roads, use of biomass fuel at home for cooking were excluded before selecting study subjects. Confounding factors which might affect PFT , like recent respiratory infection, chronic lung disorder were also excluded.

CONCLUSION

In this cross-sectional study, we found a dose-dependent, inverse association between the carbon content of airway macrophages and FEV1, and FVC in healthy children. Since we directly assessed the carbon content of airway macrophages, our data strengthen the evidence for a causal association between the inhalation of carbonaceous particles and impaired lung function in children.

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