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PULMONARY FUNCTION STATUS OF SHOPKEEPERS OF AHMEDABAD EXPOSED TO AUTOEXHAUST POLLUTANTS

N. MOHAN RAO, T. S. PATEL, C. V. RAIYANI, A. L. AGGARWAL, P. K. KULKARNI, S. K. CHATTERJEE AND S. K. KASHYAP

National Institute of Occupational Health (I.C.M.R.), Meghani Nagar, Ahmedabad - 380 016

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Abstract : The study deals with evaluation of pulmonary function status (VC, $FEV_{1\%}$ and $FEF_{25-75\%}$) in Ahmedabad shopkeepers stationed near different traffic junctions and relating them with the levels of oxides of nitrogen (NO_x) near these junctions categorised as Heavy, Medium and Low polluted area junctions. The pulmonary function test (PFT) values of heavy polluted and medium polluted area shopkeepers is compared with low polluted area shopkeepers. The influence of smoking habits and duration of exposure over PFT values was seen. The prevalence of airway obstruction in shopkeepers was compared with USA population. The results indicated significant inpairment in $FEV_{1\%}$ and $FEF_{25-75\%}$ value in high polluted area shopkeepers where NO_x level is much higher than TLV value. In medium polluted area, where NO_x level is slightly higher than TLV value, shopkeepers demonstrated significant impairment in $FEF_{25-75\%}$. Smoking is found to have an additive effect. A linear increase in the prevalence of pulmonary impairment with increasing duration of exposure was evidenced. Shopkeepers exhibited higher prevalence of impairment in both smokers and non-smokers than USA population attributing it to the effect of autoexhaust pollutants. This study also denoted that $FEF_{25-75\%}$ is an early indicator of obstruction in smaller airways which is the primary site of deposition of inhaled pollutants.

Key words : pulmonary function, airway obstruction, oxides of nitrogen, autoexhaust, duration of exposure, smoking

INTRODUCTION

In epidemiological studies in subjects exposed to community air pollutants, pulmonary function tests (PFT) are used as screening tests to determine their effects (1, 2). There is a tremendous increase in the use of automotive vehicles in India, especially in urban cities. The autoexhaust consists of oxides of nitrogen (NO_x), suspended particulate matter (SPM), carbon monoxide (CO), lead etc. Among these pollutants, oxides of nitrogen are a respiratory toxicant (3). Studies conducted in traffic police officers at Boston (USA) indicated of differences in any of the pulmonary function tests, inspite of differences in apparent exposure to autoexhaust pollutants (4). In India, a study conducted in Bombay revealed that automobile exhaust added significantly to the mortality and morbidity from ambient air pollution (5). A recent report on pulmonary function evaluation in traffic policemen exposed to automobile exhaust showed significantly higher prevalence of overall respiratory impairment in the exposed compared to referent group, but in this study environment pollutant level is not given (6).

This present study deals with the assessment of pulmonary function status in shopkeepers stationed near six different traffic junctions of Ahmedabad in relation to the environmental NO_x levels measured near those junctions. For better appreciation of the results, these junctions were categorised as heavy, medium and low basing on NO_x levels and accordingly pulmonary function status was assessed by comparing Heavy, Medium exposed categories with that of low exposed category.

METHODS

In Ahmedabad city, six traffic junctions (A, B, C, D, E and F) with varying levels of pollutants were

*Corresponding Author

selected for this study. Environmental NO_x level was determined by the method (7,8). Basing on NO_x level these traffic junctions were categorised as Heavy (A, B), Medium (C, D) and Low (E, F) polluted and average levels of these was calculated and presented. In shopkeepers stationed near these traffic junctions physical measurements (age, height and weight), duration of exposure and smoking habit was noted. Pulmonary function test (PFT) values were recorded by using vitalograph spirometer and VC, $FEV_{1\%}$ and $FEF_{25-75\%}$ are used for evaluation. The percentage of predicted VC and $FEF_{25-75\%}$ was calculated by using the regression equation of Jain and Ramaiah (9). The percentage of predicted VC, $FEF_{25-75\%}$ and $FEV_{1\%}$ value were related to different category of pollutants and a comparison was made with that of low category values. The influence of smoking habit over the impairments was assessed.

The prevalence of various pulmonary impairment was calculated basing on the percentage predicted VC and $FEV_{1\%}$ value. Percentage predicted value less than 80.0% is diagnosed as restrictive impairment and $FEV_{1\%}$ less than 75.0 as obstructive impairment and a combination of reduction of both these values as restrictive and obstructive impairments. The influence of duration of exposure over the prevalence of these impairments was observed. The overall prevalence of airway obstruction ($FEV_{1\%}$ below 75.0) of Ahmedabad shopkeepers was compared with other reported values of the USA and UK population. The relevent results are discussed.

RESULTS

The categorisation of traffic zones into Heavy, Medium and low is given in Table I. In heavy zone, the mean NO_x level is very much higher than the TLV values 80 µg/m³ specified for Indian air quality standards (10). In medium polluted zone, the NO_x level is slightly higher than TLV value and the value at low polluted zone is below TLV value. Hence a comparison of heavy and medium polluted area shopkeepers was made with that of low polluted area shopkeepers.

In Table II Anthropometric data and PFT values, revealed significant reduction in $FEV_{1\%}$, $FEF_{25-75\%}$ and low values in VC in heavy polluted shopkeepers. In medium polluted area, the shopkeepers demonstrated significant reduction in $FEF_{25-75\%}$ value and low values in VC and FEV_1. This definitely suggests that when the NO_x level is slightly higher than TLV value in medium polluted area, it is causing obstruction in smaller airways and as the pollution levels is very high as seen in heavy polluted area, it causes obstruction in smaller airways and also central and larger airways. This parameter $FEF_{25-75\%}$ is a good index of early obstruction in smaller airways.

TABLE I : Environmental NO_x level, categorisation of pollutant area and number of shopkeeper studied.

Traffic Junction	*Mean NO_x level (µg/m³)*	*Categorisation of pollutants*	*Mean NO_x level (µg/m³)*
A	164.0 N-56	Heavy	154.5
B	145.0 N-59	N-115	
C	98.3 N-40	Medium	94.2
D	90.0 N-35	N-75	
E	80.3 N-56	Low	77.2
F	74.0 N-35	N-91	

N = Number of shopkeepers.

TABLE II : Anthropometric data and pulmonary function values in shopkeepers.

Parameter	*Pollution category*		
	Heavy N=115	*Medium N=75*	*Low N=91*
Age (yrs)	31.5±11.4	29.7±10.2	28.3±10.3
Height (cms)	164.6±6.9	164.6±8.2	164.7±6.0
Weight (kg)	54.7±10.5	54.5±10.5	52.8±9.4
Duration of exposure (yrs)	9.2±8.9	8.6±8.5	8.46±8.6
VC (% of Pred)	88.2±18.1	89.1±13.3	92.5±14.5
FEV_1	80.3±9.3*	81.0±8.5	82.7±6.8
$FEF_{25-75\%}$ (% of Pred.)	81.3±30.8**	81.3±18.1**	95.9±23.0

** = Significant at 1% level compared to low polluted category.

These values observed according to smoking habits in Table III showed significant impairment in $FEV_{1\%}$ and $FEF_{25-75\%}$ in non-smokers of both heavy and medium polluted area shopkeepers, compared to low polluted area. In smokers, only heavy polluted area shopkeepers demonstrated significant decrement in $FEV_{1\%}$ and $FEF_{25-75\%}$ value. In medium polluted area smokers revealed higher loss in $FEF_{25-75\%}$ but not significantly due to small number of shopkeepers.

TABLE III : PFT values according to smoking habits.

Parameter	*Heavy*		*Medium*		*Low*	
	N.S. N=94	*S N=21*	*N.S. N=52*	*S N=23*	*N.S. N=57*	*S N=34*
VC (%of Pred.)	89.2 ±17.7	83.3* ±19.1	89.9 ±11.7	86.9 ±16.9	92.2 ±15.5	93.1 ±12.7
$FEV_{1\%}$	81.1* ±8.9	75.9*+ ±8.5	81.7 ±7.9	79.7 ±9.5	85.1 ±7.3	80.8* ±7.5
FEF_{25-75} (% of Pred.)	85.2* ±29.9	62.1**+ ±29.5	84.3* ±23.6	79.6 ±27.9	95.9 ±30.1	93.7 ±32.4

* = Significant at 5% level compared to corresponding low category group.

** = Significant at 1% level compared to corresponding low category group.

\+ = Significant at 5% level compared to Non-smokers within the same polluted category.

In Table IV, the prevalence of various pulmonary impairments is presented. There is a linear increase in prevalence from low category to heavy category and the effect was more exhibited in restrictive impairment. This suggests a dose-response relationship between the lelvels of NO_x and prevalence of impairment. This linear trend is also clearly demonstrated in duration of exposure and prevalence of impairment (Table V). With a significantly linear with respect to combined restrictive and obstructive impairment.

TABLE IV: Prevalence of ventilatory impairment in shopkeepers.

Type of impairment	*Heavy N=115*	*Medium N=75*	*Low N=91*
Restrictive (R)	27 (23.5)	15 (20.0)	15 (16.5)
Obstructive (O)	15 (13.0)	11 (14.7)	9 (9.9)
Restrictive (R) + Obstructive (O)	8 (7.0)	5 (6.7)	4 (4.4)

TABLE V: Duration of exposure and pulmonary impairment in shopkeepers.

Type of impairment	*Duration of exposure (yrs)*		
	Less than 10 N = 204	*11 - 20 N = 49*	*More than 21 N = 28*
Restrictive (R)	36 (17.6)	12 (24.5)	9 (32.1)
Obstructive (O)	21 (10.3)	10 (20.4)	4 (14.3)
Restrictive (R) + Obstructive (O)	4 (1.9)	5 (10.2) **	8 (28.6)*++

** = Significant increase at 1% level in comparison to less than 10 years value.

* = Significant increase at 5% level in comparison to 11 to 20 years value.

++ = Significant increase at 1% level in comparison to less than 10 years value.

A comparison of the prevalence of airway obstruction in shopkeeper with that of USA populations (11,12,13). The overall prevalence in Ahmedabad shopkeepers in higher than Michigan population in both smokers and non-smokers, Vermont industrial workers and Colarado general population (Table VI).

TABLE VI : Prevalence of airway obstruction in shopkeepers of Ahmedabad-A comparison with USA population.

	Study	Total	Non-smoker	Smoker
			Prevalence in percentage	
1.	Ahmedabad city (Shopkeepers)	18.5	15.2	26.9
2.	Michigan (General population)	17.1	11.1	20.5
3.	Colarado (General population)	13.0	—	—
4.	Vermont industrial workers	14.0	7.4	17.0

DISCUSSION

This approach of relating of pulmonary function status with NO_x levels categorising Heavy, Medium and Low polluted traffic junctions is made as it provides valuable information for understanding the adverse health effects due to the levels of inhaled pollutants from environment and shopkeepers are high risk group to the effects of automobile exhaust. Most of the surveys on autoexhaust pollution were carried

out on traffic policemen (6,14). Generally, the working hours for traffic policemen is about 6 to 8 hours and shopkeepers spend about 10-12 hours. We selected shopkeepers for this study as they are exposed for a longer duration than traffic policemen.

In the assessment of health effects on pulmonary function, percentage of predicted values were compared as it eliminates the effect of age, height and weight on pulmonary function. The results thus obtained evidenced predominately obstructive type (Both larger, central and smaller airways) in heavy polluted area shopkeepers (Table II) and this is corroborating with the reported observation in traffic policemen (6). The impairment of only $FEF_{25-75\%}$ in medium polluted area shopkeepers indicates the presence of smaller airway obstruction, which is an early indicator of airway obstruction. From the clinical experience and recent theory, $FEF_{25-75\%}$ is currently widely used especially as an indicator of early disease in peripheral airways in asymptomatic subjects, otherwise normal spirometry (15,16) and is relatively sensitive to alteration caused by obstructive disease in small peripheral airways (17). Impaired lung function detected by special test, consistent with damage to the small airways has been found following exposure to high levels of air pollutants, while the antecedent relationship of disease in smaller airways to chronic obstructive lung disease remains to be established, assessment of the effects of air pollution on the function of peripheral airways in populations is justified (18).

Our results also evidenced airway obstruction in heavy polluted area shopkeepers irrespective of smoking habits (Table III) but restrictive impairment was noticed only in smokers. Cigarette smoke contains significant amount of oxides of nitrogen, and an additive effect of high levels of NO_x in high polluted area might be responsible for this. This restrictive impairment evidenced by the change in duffusing capacity as a function of smoking and exposure to automobile exhaust in the reported study (19).

A linear increase in the prevalence of impairment strongly documents that NO_x is producing toxic effects on pulmonary function. This relationship was not observed in traffic policemen (6). This linear relationship is very much necessary in epidemiological study if we want to interpret that air pollutants are responsible for the decrement in PFT values and increase in prevalence rates. The high prevalence of airway obstruction in Ahmedabad shopkeepers compared to USA population, inspite differences in climate, smoking habits definitely attribute it to the effects of pollutants containing autoexhaust. Not only NO_x, but also certain levels of SO_2 and SPM are also present in the ambient environment near traffic junction, which might also playing a role. This study demonstrated in Ahmedabad shopkeepers exposed to heavy NO_x levels, produced significant impairment in pulmonary function and smoking had an additive effect.

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