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Research Article

Anthropometric profiling in pulmonary function tests to study the effect of air pollution

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Abstract

Background: Pulmonary function testing is an important practical application of respiratory physiology and has become a routine part of the evaluation of patients in whom a diagnosis of a cardiac or pulmonary abnormality or disease is entertained. Effectiveness of ventilation is determined by the mechanical properties of lung parenchyma, airways, chest wall and the magnitude of force applied to these, which at any given moment reflect the dynamic, equilibrium between the activity of respiratory and the retractile forces of the chest bellows.

Material and Methods: The study group included 144 subjects, while the control group included 148 subjects. The subjects included in both the groups are normal, healthy, non-smoking hard working males, working in their respective environments, 8-10 hours a day for a period of not less than 10 years. The ventilatory parameters included in this comparative study are FVC; FEV_1; FEV_1/FVC%; PEF; $FEF_{25-75\%}$; Vmax25%; Vmax50% & Vmax 75%. Mean & SD values of the ventilatory function tests in the study group and control group were calculated separately. Mean difference was tested using "t" test. The Chi-Square test is applied to find out the significant difference of a particular parameter between the study group & control group. Data was analyzed using SPSS package.

Results and conclusion: Among the ambient air pollutants, the most dangerous to the respiratory system are particulate matter (PM_{10}) and sulphur dioxide (SO_2) produced by combustion of fossil fuels. These pollutants react with each other, forming hazardous acid sulfate particles, which are capable of reaching deep inside the tracheo-bronchial tree producing a bronchoconstrictor response, as their predominant site of action are the small airways. This is reflected by a sharp decline in the results of the small airways ventilatory parameters like $FEF_{25-75\%}$ and Vmax75% of the study group when compared to those of the control group, thus establishing an early onset of small airways' dysfunction.

Keywords: Anthropometric profiling; pulmonary function tests; air pollution

1. Introduction

Pulmonary function testing is an important practical application of respiratory physiology and has become a routine part of the evaluation of patients in whom a diagnosis of a cardiac or pulmonary abnormality or disease is entertained[1].

Effectiveness of ventilation is determined by the mechanical properties of lung parenchyma, airways, chest wall and the magnitude of force applied to these, which at any given moment reflect the dynamic, equilibrium between the activity of respiratory and the retractile forces of the chest bellows. Adequate and efficient ventilation results in a uniform distribution of inspired air to the different regions of the lungs and thus bringing about adequate renewal of alveolar air[2].

Alveolo-capillary exchange of gases is a dynamic process, which is determined on one hand by alveolar ventilation and on the other hand by circulation of blood through the alveolar capillaries. The diffusion of gases across the alveolo-capillary interphase is a function of the partial pressure gradient of these gasses and varies throughout the ventilatory cycle. These partial pressure gradients in turn reflect the dynamic equilibrium between alveolar ventilation and pulmonary circulation[2].

Pulmonary function tests are used to evaluate and monitor diseases that affect the heart and lung functions, to monitor the effects of environmental, occupational and drug exposures, to assess the risks of surgery and to assist in evaluations performed before employment or for insurance purposes. They are also included in many evaluations of fitness and in some routine physical examinations. Pulmonary-function testing is sometimes indicated when there may be more than one explanation for a patient's symptoms. Pulmonary-function testing besides identifying abnormalities; allow the severity of an abnormality to be quantified and in estimating the extent upto, which a specific abnormality to be quantified and in estimating the extent upto, which a specific abnormality can be reversed with appropriate therapy[3].

2. Material and Methods

Ventilatory function tests obtained using a computerized spirometer in a sample of population from the K.R. market area (study groups) were compared with those obtained from the rural population (control group).

The study group included 144 subjects, while the control group included 148 subjects. The subjects included in both the groups are normal, healthy, non-smoking hard working males, working in their respective environments, 8-10 hours a day for a period of not less than 10 years.

The ventilatory parameters included in this comparative study are FVC; FEV_1; FEV_1/FVC%; PEF; $FEF_{25-75\%}$; Vmax25%; Vmax50% & Vmax75%.

Mean & SD values of the ventilatory function tests in the study group and control group were calculated separately. Mean difference was tested using “t” test. The Chi-Square test is applied to find out the significant difference of a particular parameter between the study group & control group. Data was analyzed using SPSS package.

3. Results

Table: 1 Age-wise comparison of mean values of Height, Weight, Ventilatory parameters of Study Group & Control Group

Age	Group		Height	Weight	F.V.C	FEV_1	PEF	FEV_1 % FVC	FEF25-75%	Vmax25%	Vmax50%	Vmax75%
20-25 Years	Study Group (N=40)	Mean SD	167.02 6.65	55.80 6.75	3.80 0.68	2.99 4.41	7.63 1.68	79.36 6.57	2.82 0.59	5.80 1.55	3.27 0.72	1.31 0.33
	Control Group (N = 50)	Mean SD	166.12 7.92	54.18 5.15	4.01 0.60	3.50 0.46	9.32 1.34	87.61 3.95	4.56 0.65	7.94 1.17	5.06 0.71	2.32 0.39
	t value		-0.589	-1.254	1.546	5.646	5.153	7.000	13.38	7.281	11.84	13.30
	p value		>0.05	>0.05	>0.05	<0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05
26-30 Years	Study Group (N=54)	Mean SD	168.94 5.95	58.78 5.95	3.69 0.55	2.84 0.44	7.43 1.71	77.24 6.85	2.56 0.67	5.48 1.41	3.03 0.78	1.14 0.42
	Control Group (N = 49)	Mean SD	168.14 6.09	56.86 6.60	3.97 0.41	3.38 0.34	9.26 1.17	85.18 3.87	4.51 0.93	7.81 1.09	5.08 1.02	2.24 0.61
	t value		-0.688	-1.545	2.964	6.938	12.123	7.327	12.123	9.437	11.370	10.687
	p value		>0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
31-35 Years	Study Group (N =16)	Mean SD	170.38 5.46	59.38 6.70	3.45 0.44	2.65 0.39	7.64 1.20	77.02 6.31	2.17 0.56	5.13 1.24	2.61 0.76	0.88 0.24
	Control Group (N=17)	Mean SD	167.35 7.42	60.47 8.64	3.82 0.38	3.21 0.28	9.08 1.26	84.83 3.99	4.16 0.66	7.44 0.97	4.65 0.68	1.87 0.48
	t value		-1.338	0.408	2.539	4.684	3.895	9.347	3.360	5.953	8.152	7.556
	p value		>0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
36-40 Years	Study Group (N=11)	Mean SD	166.91 5.11	58.55 7.75	3.37 0.58	2.48 .42	7.58 1.13	73.81 5.15	2.05 0.65	5.17 1.37	2.44 0.67	0.90 0.37
	Control Group (N = 12)	Mean SD	168.92 7.45	60.58 8.18	3.58 0.43	2.97 0.30	8.18 0.76	83.27 5.28	3.92 1.11	6.71 1.14	4.66 1.42	1.66 0.34
	t value		0.759	0.613	0.991	3.164	1.469	4.350	4.981	2.924	4.869	5.057
	p value		>0.05	>0.05	>0.05	<0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05
41-45 Years	Study Group (N=10)	Mean SD	167.70 5.62	63.00 3.53	3.43 0.59	2.62 0.39	7.97 1.48	77.03 6.17	2.36 0.51	5.78 1.40	3.06 0.78	1.02 0.30
	Control Group (N=13)	Mean SD	170.92 4.27	59.69 6.94	3.60 4.5	2.93 0.35	9.22 1.33	81.45 2.25	3.18 0.52	7.25 1.30	3.80 0.66	1.38 0.40
	t value		1.509	-1.486	0.755	1.927	2.095	2.159	3.784	2.571	2.422	2.471
	p value		>0.05	>0.05	>0.05	<0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05
46+ Years	Study Group (N=13)	Mena SD	170.00 5.02	61.31 5.84	3.34 0.39	2.45 0.29	7.40 1.35	74.19 10.84	2.07 0.62	5.08 1.54	2.58 0.95	0.85 0.32
	Control Group (N=7)	Mean SD	167.29 5.35	62.00 8.29	3.44 0.26	2.80 0.24	8.09 0.92	81.42 2.00	3.54 0.42	6.88 0.86	4.11 0.44	1.48 0.24
	t value		-1.106	0.196	0.686	2.855	1.338	2.334	6.313	3.354	4.907	4.897
	p value		>0.05	>0.05	>0.05	<0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Table: 2 Mean values of Height, Weight & Ventilatory Parameters in Age groups <= 30 years & > 30 years in study group & control group

Age	Group		Height	Weight	F.V.C.	FEV_1	PEF	FEV_1 % FVC	FEF_{25-75}%	Vmax 25%	Vmax 50%	Vmax75%
<=30 Years	Study Group (N=94)	Mean SD	168.13 6.17	57.51 6.44	3.74 0. 61	2.90 0.43	7.51 1.69	78.14 6.78	2.67 0. 65	5. 61 1. 47	3.13 0.76	1.21 0.40
	Control Group (N = 99)	Mean SD	167.12 7.11	55.51 6.03	3.99 0.51	3.44 0.41	9.29 1.25	86.41 4.08	4.54 0.79	7.88 1.13	5.07 0.87	2.28 0.51
	t value		-1.05	0.618	3.14	8.90	8.25	10.20	17.94	11.97	16.50	16.52
	p value		>0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
>30 Years	Study Group (N = 50)	Mean SD	168.98 5.35	60.42 6.27	3.40 0 .48	2.56 0.37	7.63 1.26	75.58 7.46	2.16 0.58	5.25 1.37	2.65 0 .80	0.91 0.30
	Control Group (N= 49)	Mean SD	168.67 6.44	60.51 7.83	3.65 0.41	3.02 0.33	8.75 1.21	82.86 3.87	3.75 0.82	7.13 1.10	4.35 0 .95	1.63 0 .44
	t value		-0.26	0.06	2.76	6.50	4.52	6.11	11.12	7.53	9.60	9.60
	p value		>0.05	>0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

4. Discussion

The respiratory tract is an important route of exposure and thus the critical target organ system for many commonly inhaled pollutants except carbon monoxide. Important intermediate factors in this process influence whether an exposure does or does not result in a measurable effect or health outcome and include the pollutant's concentration, its physical and chemical characteristics, the exposed individual's location (microenvironment) and activity pattern, the duration (contact time), and the susceptibility of the exposed individual[4].

Exposure is a defined as the contract between the body and the external environmental pollutant. Exposure is one (but not the only) the important determinant of the dose of an agent at respiratory sites. Important components of exposure are generally the concentration of the agent in inhaled air, the duration of inhalation, and the amount of ventilation during the period. The same net exposure may be achieved by various combinations of concentration, duration, and ventilation rates. However, short-term peak exposures may elicit biologic effects different from those observed in longer-term, lower-level exposures with the same product of concentration, time and ventilation rate.

Another important link in the pathway from pollutant to health effect is the internal dose, which is the quantity of agent deposited at a target site within the body where toxic effects occur. The dose of an air pollutant is a critical determinant for a health effect, but dose is more difficult to measure than exposure. Dose and exposure are not necessarily equivalent for inhaled particles and gases, although the likelihood of a health effect shows a strong positive correlation with exposure as well as dose.

The health effects of ambient air pollution can be divided into four groups.

1. Short term or acute respiratory effects: These include asthmatic attacks, hyperactive airways, respiratory infections and reversible changes in lung functions. Ambient air pollutants like SO_2, PM_{10}, O_3, and NO_2 are known to stimulate airway reactivity. The incidence of respiratory infections, such as cold, influenza & sore throat infections are alleviated with an increase in the concentration of SO_2 & PM_{10} in the ambient air Transient impairment of ventilatory functions occur when air pollution levels are high, which may reverse initially to normal.
2. Long term or chronic respiratory effects: These include Chronic Obstructive Pulmonary Disease (COPD) & pre-mature aging of the lungs.
3. Lung Cancer: Cancer causing pollutants in the atmosphere are benzo (a) pyrene & dioxins, fibers such as asbestos, metal dusts such as arsenic and cadmium, Tobacco smoke interacts synergistically with other carcinogens to increase the indulging cancer risk of either material.
4. Non-respiratory effects: Certain airborne pollutants affect organs in the body other than the respiratory system, these include CO, which by binding irreversibly with haemoglobin, reduces oxygen carrying capacity of the blood, thus the maximal rate of oxygen delivery to the body tissues is decreased, potentially limiting maximal oxygen uptake by the exercising muscles. Thus patients with coronary vascular disease are vulnerable to acute myocardial ischaemia when exposed to CO for a long time. Air-borne lead causes nervous disorders in children, including learning disabilities and hyperactivity, kidney damage leading to high blood pressure in both children and adults. Benzene causes leukemia. In the eye, there is an alteration in light-sensitivity when COHb exceeds 5%.

5. Conclusion

Among the ambient air pollutants, the most dangerous to the respiratory system are particulate matter (PM_{10}) and sulphur dioxide (SO_2) produced by combustion of fossil fuels. These pollutants react with each other, forming hazardous acid sulfate particles, which are capable of reaching deep inside the tracheo-bronchial tree producing a bronchoconstrictor response, as their predominant site of action are the small airways'. This is reflected by a sharp decline in the results of the small airways' ventilatory parameters like $FEF_{25\text{-}75\%}$ and Vmax75% of the study group when compared to those of the control group, thus establishing an early onset of small airways' dysfunction.

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