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Research article

PEAK EXPIRATORY FLOW RATE IN ASYMPTOMATIC MALE WORKERS EXPOSED TO CHEMICAL FUMES, IN VARIOUS INDUSTRIES OF HYDERABAD

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ABSTRACT

Context: The prevalence of occupational health hazards and mortality has been reported to be unusually high among people of India. Although developed countries are very much careful about the health in occupations it is quite neglected in the developing countries like India. **Aims:** To record PEFR in asymptomatic male workers exposed to chemical fumes for more than 2 years and compare the results with age matched unexposed, healthy male controls. **Methods and Material:** This was a comparative study between 50 asymptomatic male workers exposed to chemical fumes for more than 2 years in various industries located at Jeedimetla Industrial Area and 50 unexposed healthy male individuals from general population. The sampling was done by simple random sampling (lottery method). The data was collected in the Research Laboratory of Physiology. Anthropometry like weight, height, was measured and the PEFR test was performed in the standing position by taking a deep inspiration and then blowing out as hard and as quickly as possible with their nose closed. Data was analyzed by using SPSS package and was expressed in terms of mean ± SD. **Results:** It was observed that mean PEFR was statistically highly significant in cases ($p = 0.0001$), and PEFR decreased with increase in duration of exposure. **Conclusions:** Thus, it can be concluded that apparently healthy individuals may also have abnormal PEFR findings. Hence, a regular check on these parameters will help them in reducing the chances of its manifestation at a future date.

Key words: Peak expiratory flow rate; PM10; Chemical fumes; Peak flow meter.

INTRODUCTION

Pollution and its effect on the people is a global threat. It is increasing day by day due to effluents and emissions from industries, solid waste disposal, automobile exhaust and degradation of soil by removing the green belt and high use of pesticides. The particulate matter that remains in a suspended state in the troposphere, such as solid particles (from combustion processes, industrial activities and natural sources), liquid droplets etc. Floating in the air is referred to as Particulate pollutants. [1] Of greatest concern to the public health are the particles smaller enough to be inhaled into the deepest parts of the lung. These particles are less than 10 microns in diameter, about l/7th the thickness of a human hair and are known as PM10.[2] PM10 is a major component of air pollution that threatens both our health and environment. A large number of epidemiological studies have shown that day-to-day variations in concentrations of particles are associated with adverse effects on health. These include increased daily deaths, increased admissions of patients to hospitals suffering from heart and lung disorders and a worsening of the condition like asthma.[3]

All employers and self-employed people have duties under health and safety law to assess risks in the workplace. The risk assessment forms the basis of the Safety Statement that is required for all workplaces. The Safety, Health and Welfare at Work (Chemical Agents) Regulations, 2001 specifically obliges employers and self-employed persons to assess the risks arising from the use or presence of chemical agents in the workplace.[4] This is intended to help employers in assessing the risks that relate to chemical agents in the workplace and in determining adequate precautions or control measures to safeguard health and safety. The intention is to prevent accidents or work related ill-health in the workplace. The effects of hazardous chemicals may be immediate or long-term and range from mild eye irritation to chronic lung disease.

In diagnosis and treatment of respiratory diseases, the assessment of lung functions is of considerable importance, key tests being vital capacity (VC), forced vital capacity (FVC), maximum expiratory flow rate (MEFR) or peak expiratory flow rate (PEFR), maximum ventilator volume (MVV).[5] So, normal reference values for lung function tests of any population need to be assessed. PEFR measurement by peak flow meter is an easy way to measure lung functions in field study.[6,7]

PEFR is the maximum rate of air flow achieved during a forced expiration after maximal inspiration.[5,6,7] Lung functions including PEFR are affected by various factors such as sex, body surface area, physical activity, posture, environment, racial differences etc.[8,9,10,11] However, there is scanty literature about PEFR in Jeedimetla population of Hyderabad where many industries are located. So, this study was taken up to detect any PEFR changes occurring significantly in asymptomatic workers, exposed to chemical fumes in various industries located at Jeedimetla Industrial Area, Hyderabad and to study the prevalence of such abnormal PEFR findings and thereby predict future respiratory diseases in these individuals.

For different respiratory disease treatment, routine lung function measurement is required to follow up the patients. And for this reason PEFR is one of the best choices. This is a simple method of measuring airway obstruction and it will detect moderate or severe disease. The simplicity of the method is its main advantage. It measures the airflow through the bronchi and thus the degree of obstruction in the airways.

MATERIAL AND METHODS:

Source of data: This is a comparative cross-sectional study between asymptomatic male workers exposed to chemical fumes like azodicarbonamide, unheated polyvinyl chloride, nitrites etc for more than 2 years in various industries located at Jeedimetla Industrial Area and age matched unexposed healthy male individuals from general population. This area was selected as it is served by the Malla Reddy Hospital. Ethical Clearance was obtained by the Institution's Ethical Clearance Committee. There are about 25 industries using various chemicals. Permission was obtained from the concerned staff and only those industries that permitted us to perform the study on their workers were selected.

An initial survey was done to list out the asymptomatic male workers who were exposed to the chemical fumes and the unexposed workers. The sample size was calculated by the formula $4pq/E^2$ and the sampling procedure was done by simple random sampling (lottery method).[12] 50 cases were randomly selected from this group. Age matched 50 healthy male individuals were taken as controls from the general population.

Inclusion criteria:

1. Apparently healthy male workers exposed to chemical fumes for more than 2 years.
2. Apparently healthy age matched controls not exposed to chemical fumes.

Exclusion criteria:

1. Subjects with exposure to chemical fumes for less than 2 years.
2. Subjects with previously diagnosed pulmonary diseases and recent hospitalizations.
3. Subjects on any medications.
4. Subjects with smoking history or tobacco chewing, past or present.
5. Subjects with symptoms of cough, haemoptysis, wheeze etc.
6. Subjects not consenting for PEFR study.

Instruments used were vertical height scale, weighing machine and Peak Flow Meter Breathe-O meter of

Cipla Company. A pre-designed questionnaire was given consisting of objective-type questions with multiple choice responses. All the participants were requested to fill the form which was verified thoroughly by interview. The weight in kilograms and height in meters was measured as per the standard guidelines laid down by World Health Organization.[13] Height (HT) was measured in barefoot to the nearest 0.1cm using a vertical height scale. Body weight (WT) was recorded to the nearest 0.1 kg using a portable weighing machine. Body Mass Index[14] was calculated using the standard formula weight (in Kg) divided by height (in metre) squared (kg/m^2).

General Physical Examination as well as Systemic Examination was done to rule out the exclusion criteria. Vital signs like Pulse (beats/min), Blood Pressure (BP) (mmHg), Respiratory rate (RR) (cycles/min) and temperature (°C) were noted. Blood pressure (systolic-SBP, diastolic-DBP) was recorded in the supine position in the right upper arm after the subject had rested for at least 5 minutes with a standard mercury sphygmomanometer (Diamond) to the nearest 2 mm Hg.[15] After a thorough history taking and clinical examination; the procedure was explained to the subjects. Prior to recording the subject's PEFR, the use of the instrument was repeatedly demonstrated and explained.[16] The PEFR test was performed in the standing position with the peak flow meter held horizontally. A tight fitting disposable cardboard mouthpiece was inserted in the inlet nozzle. The subjects were asked to take deep inspiration and then blow out as hard and as quickly as possible with their nose closed. The procedure was repeated three times and the best of three ratings were recorded.[16] The PEFR was recorded in L/min and compared with the predicted normal values for that height using the formula **PEFR (L/min) = [Height (cm) - 80] x 5**

If the subject suffered from any health problems during the course of the study or if his PEFR was abnormal, then treatment was given at the Malla Reddy Hospital. At the end of the study, health education was given to all the participants regarding personal protective measures.

Statistical methods: Data was analyzed by applying appropriate statistical tests by using SPSS package version number 14. Data was expressed in terms of mean ± SD. Unpaired't' test was applied to estimate the difference between two groups of population. P value < 0.05 was taken as significant.

RESULTS

Table 1: Age wise distribution of Cases and Controls

Age (years)	Number of Cases (N)	Number of Controls (N)
21 – 30	10 (20%)	10 (20%)
31 – 40	14 (28%)	14 (28%)
41 – 50	11 (22%)	10 (20%)
51 – 60	13 (26%)	14 (28%)
61 – 70	2 (4%)	2 (4%)
Total	**50 (100%)**	**50 (100%)**

The cases and controls were classified into five different age groups and were statistically non-significant.

Table 2: Anthropometric Characteristics in Cases and Controls

Anthropometry	Cases (N = 50)	Controls (N = 50)
Height (cms)	157.5 ± 6.74	155.2 ± 4.12
Weight (kg)	48.4 ± 4.82	50.9 ± 4.08
Body Mass Index (kg/m^2)	19.67 ± 0.715	21.21 ± 0.33

Height: The mean height (in cms) in cases was 157.5 ± 6.74 and in controls was 155.2 ± 4.12. Weight: The mean weight (in kgs) in cases was 48.4 ± 4.82 and in controls was 50.9 ± 4.08. Body Mass Index: The mean BMI (in kg/m^2) in cases was 19.67 ± 0.715 and in controls was 21.21 ± 0.33.

Table 3: Height and Peak Expiratory Flow Rate in two groups

Age (yrs)	Group	Height (cms)	Predicted PEFR (l/min)	Obtained PEFR(l/min)	Unpaired 't' test
21 – 30	Cases	150.5± 5.8	352.5± 4.12	350.1± 4.7	t = 6.4387
	Control	152.2± 3.1	361.0± 0.02	360.5± 2.0	p = 0.0001*
31 – 40	Cases	152.4± 6.2	362.2 ± 0.5	300.7± 4.4	t = 44.7612
	Control	150.2± 1.1	360.0± 0.01	361.5± 2.4	p = 0.0001*
41 – 50	Cases	151.9± 7.1	359.8±4.2	321.2± 2.3	t = 38.5781
	Control	152.2± 3.1	358.0±1.0	358.4± 2.1	p = 0.0001*
51 – 60	Cases	153.6± 4.2	368.0±0.4	304.7± 3.4	t = 57.9368
	Control	154.2± 4.1	369.0±0.4	368.5± 2.1	p = 0.0001*
61 – 70	Cases	159.7± 7.2	398.5 ± 4.4	322.2± 0.3	t = 13.9267
	Control	158.2± 3.1	396.8 ± 1.2	390. ± 6.9	p = 0.0051*

***p < 0.001 (Highly Significant)**

PEFR values were compared in cases and controls depending upon their age group and height by applying unpaired't' test. Subjects in various age groups of 21 – 70 years had reduced mean PEFR (l/min) which was highly significant. (p = 0.0001). Although in the age group of 31 – 40, 51 – 60 and 61 – 70 there was a significant difference between the predicted PEFR and the obtained PEFR, the other two age groups of 21 – 30 (years) and 41 – 50 (years) did not show considerable differences in the mean PEFR values. Mean PEFR values were compared between cases and controls. It was found that the mean PEFR was significantly reduced among cases when compared to controls across all age groups (p = 0.0001).

Table 4. Duration of Exposure and PEFR

Duration of Exposure	PEFR (l/min)	Number of Cases
< 5 years	321.21 ± 2.3	20
> 5 years	292.31 ± 3.2	30
t = 34.7902 p = 0.0001		

In 20 subjects with duration of exposure of 2 - 5 years the mean PEFR (l/min) was 321.21 ± 2.3.

In 30 subjects with duration of exposure of more than 5 years the mean PEFR (l/min) was 292.31 ± 3.2. This difference was statistically significant (p = 0.0001). Hence, it can be concluded that as the duration of exposure is more, the PEFR will decrease.

DISCUSSION

The prevalence of occupational health hazards and mortality has been reported to be unusually high among people of India. Although developed countries are very much careful about the health in occupations it is quite neglected in the developing countries like India. There is a widespread misconception that occupational health is mainly concerned with industry and industrialized countries. But in a country like India, millions of people work as daily wages, labour like stone grinding, paddy thrashing, weaving etc. These workers often face health hazards during occupational activities. For example, in agricultural fields with increasing use of chemicals either as fertilizers, insecticides, pesticides agricultural workers are exposed to toxic hazards from these chemicals and particulate pollutants and thus face a multitude of health problems.

Under the WHS Regulations, a hazardous chemical is any substance, mixture or article that satisfies the criteria of one or more Globally Harmonized System of Classification and Labeling of Chemicals (GHS) hazard classes.[17] In our study the subjects were exposed to various chemical fumes and dust like polyvinylchloride, azodicarbonamide etc. PEFR measurement by peak flow meter is an easy way to assess lung capacity and ventilatory functions of the subjects. The lung function tests, including PEFR are influenced by various factors such as age, body size, physical activity, and environmental condition. [9,10]

In this present comparative study, we have compared the age, anthropometric characteristics, mainly height and PEFR of 50 asymptomatic male workers exposed to chemical fumes for more than 2 years and 50 age matched apparently healthy unexposed controls from the general population. PEFR values were compared in cases and controls, depending upon their age group and height. Subjects in all age groups had reduced mean PEFR (l/min) which was highly significant (p = 0.0001). In the age group of 31 – 40, 51 – 60 and 61 – 70 years, there was a significant difference between the predicted PEFR and the obtained PEFR but the other two age groups of 21 – 30 and 41 – 50 years, did not show considerable differences in the mean PEFR values. On comparing the mean PEFR values with the controls, all the age groups showed statistically highly significant p values (p = 0.0001).

In a similar study done by Dhungel et al[18] they observed that the age of the subjects was significant (p < 0.01) correlated with PEFR even when BMI was controlled. Height of the subjects was found to be significantly correlated with PEFR when weight was partialed out but weight of the subjects was not significantly correlated when height was partialed out. So, they concluded from the above findings that height was the main factor which may influence PEFR but not the weight.

Our study also showed that PEFR decreases with increase in duration of exposure. The 't' value was 34.7902 and p = 0.0001 which was highly significant. Dust exposure present a significant risk in some workplaces, usually occur where combustible dusts (or fibers, for example from paper, grain, finely divided organic compounds and metals) have accumulated and are then disturbed and released into the air, coming into contact with an ignition source. Common ways in which dusts can be disturbed include from wind, when opening doors or windows, during cleaning or sweeping up of waste or using compressed air to blow out material accumulated in crevices, gaps or in machinery. Dust-air mixtures can be classified as hazardous atmospheres in the same way as other flammable materials like vapors from flammable liquids and gases.[19,20,21] Limitations of our study were the small sample size, and we did not correlate the duration of exposure with PEFR, and the BMI with PEFR, which would be our future projects. We also did not estimate for any airway disorders, or other hazards of industrial fume exposure.

CONCLUSION

- Industrial workers may develop respiratory changes depending upon the chemical fumes and dust exposure.
- PEFR decreases with increase in duration of exposure to fumes and dust.
- A risk assessment is mandatory for hazardous chemicals, for example, when working with asbestos.
- It will help to identify which workers are at risk of exposure
- Determine what sources and processes are causing that risk
- Identify what kind of control measures should be implemented
- Check the effectiveness of existing control measures.

Maintenance of control measures may involve the following:

- ➢ Regular inspections of control measures
- ➢ Supervision to ensure whether workers are using the control measures properly
- ➢ Preventive and testing programs for chemical storage and handling systems
- ➢ Periodic air monitoring to ensure that engineering and administrative controls remain effective.

Information, training, instruction and supervision must be provided not only to workers but to other persons at the workplace such as visitors. It must be provided in such a way that it is easily understood. The extent of training should depend on the nature of the hazards and the complexity of the work procedures and control measures required to minimize the risks. Health monitoring is to be taught to identify changes in the person's health status because of exposure to certain substances.

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Conflict of Interest: Nil

REFERENCES

1. Debray P, Misra J, Ghosh C. Peak expiratory flow rate and cardio-respiratory fitness of Bengali workers exposed to dust and plant source particulate matters. Indian Journal of Community Medicine 2002; 27(4):171- 76.
2. Donaldson K, Brown DM, Mitchell C, Dineva M, Beswick PH, Gilmour P et al. Free radical activity of PM10: iron-mediated generation of hydroxyl radicals. Environ Health Perspect. 1997; 105(5):1285-89.
3. HMSO. Committee on the Medical Effects of Air Pollutants. Non-Biological Particles and Health. London, 1995.
4. Health and safety authority, 10 Hogan Place, Dublin 2. 2004. www.hsa.ie
5. Pocock G, Christopher DR. Human Physiology: the basis of medicine. Oxford University press, 1999:337.
6. Wright BM, Mc Kerrow CB. Maximum Forced Expiratory Flow as a measure of ventilatory capacity. British Med J 1959; 2(5159):1041-47.
7. Agarwal AN. Measurement of interpretation of peak expiratory flow. Indian J Physiol Pharmacol. 1998; 42(4):567-68.
8. Singh HD, Peri S. Peak expiratory flow rates in South Indian adults. Indian J Physiol Pharmacol. 1979; 23(4):315-20.
9. Benjaponpitak S, Direkwattanachai C, Kraisarin C, Sasisakulporn C. Peak expiratory flow rate values of students in Bangkok. J Med Assoc Thai. 1999; 82:137-43.
10. Srinivas P, Chia YC, Poi PJ, Ibrahim S. Peak expiratory flow rate in elderly Malaysians. Med J

Malaysia. 1999; 54(1):11-21.
11. Raju PS, Prasad KV, Ramana YV, Murthy KJ. Pulmonary function tests in Indian girls - prediction equations. Indian J Pediatr. 2004; 71(10):893-97.
12. Armitage P, Berry G, Matthews JNS. Statistical methods in Medical Research. Blackwell Publishing. 2002; 4th ed: 137-46.
13. World Health Organization–Physical status: The use and interpretation of anthropometry: WHO Tech Rep series 1995; 854:424-38.
14. WHO: Global Database on Body Mass Index. BMIclassification2004http;//apps.who.int/bmi/index.
15. Mancia G. Methods for assessing blood pressure values in humans. Hypertension. 1983;5(5) :III5-III13.
16. Ghai CL. A textbook of Practical Physiology. Jaypee Brothers Medical Publishers (P) LTD. 2013; 8th edition: 154-56.
17. Managing risks of hazardous chemicals in the workplace. Code of Practice 2012.
18. Dhungel KU, Parthasarathy D, Dipali S. Peak expiratory flow rate of Nepalese children and young adults. Kathmandu University Medical Journal. 2008; 6(3):346-54.
19. Soutar CA, Copland LH, Thornley PE, Hurley JF, Ottery J, Adams WGF, et.al. Epidemiological study of respiratory disease in workers exposed to polyvinylchloride dust. Thorax. 1980; 35:644-52.
20. Soutar CA, Gauld S. Clinical studies of workers exposed to polyvinylchloride dust. Thorax 1983; 38: 834-39.
21. AJM Slovak. Occupational asthma caused by a plastics blowing agent, azodicarbonamide. Thorax. 1981; 36:906-09.