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Annals of Biological Research, 2010, 1 (1) : 224-229
(http://scholarsresearchlibrary.com/archive.html)

Biological effect of air pollution from the leather tanneries in Vellore district in reference to the chronic obstructive pulmonary disease (COPD)

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Introduction

Vellore district is a major leather- processing centre in Tamil Nadu, with an estimated 50,000 tannery workers.[1-3].Leather production includes many operations with different exposures, which can be harmful for the health of the tannery workers as well as nearby dwellers, particularly carcinogenic to humans. Some chemicals used in the tanning processes such as chromate and bichromate salts, ethanol, benzene, toluene, aniline, butyl acetate, sulphuric acid and ammonium hydrogen sulphide are considered as carcinogenic [4,5].

An important health risk factor for the tannery workers and people who are living around that areas are intense and prolonged exposure to leather dusts, ozone, chromium, NO_2, SO_2, CO, H_2S and CH_4. These gaseous pollutants particularly chromium may enter the body by inhalation, ingestion and by direct cutaneous contact. Certain particulate hexavalent chromium [Cr(VI)] compounds are human respiratory carcinogens that release genotoxic soluble chromate, and are associated with fibrosis, fibrosarcomas, adenocarcinomas and squamous cell carcinomas of the lung and also causes dermatitis, ulcers and nasal cancers. [6-10]. Workers and nearby dwellers of the tanneries who are exposed to these particles and gases evolved from tannery waste water are subject to airflow obstruction which leads to chronic obstructive pulmonary disease (COPD).

COPD is characterized by a progressive, irreversible decline in lung function. In normal conditions, lung function achieves maximum values at the age of 20-25, followed by a slow, progressive decline due to ageing. When symptoms appear, most of the volume and flow capacity has already been lost.[11,12]After years of suffering dyspnoea and disability, many patients with COPD die as a consequence of the disease[13]

The short-term study on effects of air pollution, was based on doctor diagnosis, death certificates, Clinical records and self–reported daily variations of symptoms, treatment in patients with a diagnosis of COPD based on clinical and spirometric of criteria. This has excluded studies on asthmatics with COPD but it has included studies on lung function at all ages.

COPD is still an open issue which has been approached from a clinical perspective where the dominant needs are diagnosis of exacerbations of the disease and treatment.[14,15] All though acute exacerbations are considered to be the most common cause of hospital admission in COPD patients in age limit between 35 to 90 and the studies have used the diagnosis labeling stated in medical records.

Many studies have shown definite link between current daily levels of air pollution and daily mortality by respiratory and cardiovascular causes in the general population.[16] The purpose of the study was, therefore, to investigate the adverse health effects of exposure to gaseous pollutants including chromium salts from leather tanneries waste water. We assessed the interlink between daily levels of air pollutants and daily mortality in a cohort of COPD patients and diagnosed the mild, moderate and severe restriction and obstruction effects of COPD patients in Vellore districts for the years 2006 to 2009.[17,18]

Materials and Methods

The leather tannery workers and dwellers from various places of Vellore district attending emergency room services (hospitals) either for asthma or COPD were recruited during the years 2006 to 2009. Vital status was obtained through record linkage of the people of the cohort with the Catalonia Mortality Registry for the years 2006 to 2009.[18] A total of 500 people (of the 1000 in the initial cohort) had a diagnosis of COPD, 50 of whom died in the period 2006 to 2009 and were used in this analysis.

Daily information on levels of leather dusts, ozone (O_3), chromium (VI), nitrogen dioxide (NO_2), sulphur dioxide(SO_2), carbon monoxide(CO), hydrogen sulphide(H_2S) methane(CH_4), temperature and relative humidity was collected from various places in Vellore district.[19] Poisson regression time series models were fitted for each pollutant (in a log-linear form) and each different category of mortality following the APHEA methodology.[20]and adding the natural logarithm of the number of patients are still alive. To evaluate dyspnea and determine the obstruction and restriction of the affected COPD patients, the following parameters were studied.

1. Air monitoring of chromium and gaseous pollutants

External exposure at the work places and surrounding areas were estimated by personal air monitoring during the work shift. The airborne particulate sampling was performed on quartz microfiber filters (Whatmann QM-A, diameter 37 mm) in Millipore filter holders. The concentrations of the total particulate were determined by weighing the filter and calculated in milligrams per cubic meter.

2. Personal and occupational history

The personal history included details of personal characteristics, age, smoking history, alcohol and tobacco consumption and family history, socioeconomic status and living conditions whereas the occupational history included details of job, duration and type of exposure and details of toxicants at the work place.

3. Clinical examination

A detailed physical examination of the nervous, respiratory, cardiovascular, demal and musculoskeletal system was conducted at a health examination camp set up at the work place in the tannery industry.

4. Lung function testing

A precalibrated portable computerized spirometer (Auto spiror Model HS-1, Tuda aptics, Japan) was used to record the spirometric functions. The observed values were compared with the predicted values of Rastogi et al. The peak expiratory flow rate was measured by a peak flow meter (standard model-clement clake, U.K) and the highest values were taken into account.

5. Bronchodilator reversibility test

Individuals are affected with COPD are evaluated with the institution of bronchodilators and inhalers using spirometry.

6. X- ray chest radiography

The clinically positive respiratory cases were subjected to a chest X-ray (PA view) on a 100 MA X-ray machine to confirm the clinical findings.

7. High Resolution CT Scan – Study of thorax

Studies using CT Scan can be divided into those using visual assessment of low –density areas of the scan, which can be either semi-quantitative or quantitative, and those using Ct scan density to quantify areas of low X-ray attenuation.

8. ECG testing

To evaluate cardiac and respiratory status of individuals affected with COPD.

Results

All studies consistently indicate a higher prevalence of symptoms of breathlessness or COPD in areas with higher particulate air pollution due to evolution of higher percentage of leather dusts, ozone, chromium, NO_2, SO_2, CO, H_2S and CH_4 from the tannery waste water. Studies on daily admissions in emergency rooms and hospital admissions were specific for COPD conducted during the 2006 to 2009 in different towns in vellore district where tanneries located have consistently observed that admissions due to COPD increased on days with high pollution values. The percentage of particles and gaseous pollutants were higher in nearby tannery areas and slowly decreases in far away places from leather tanneries.

Table 1: Cross sectional and cohort epidemiological studies on lung function and air pollution

Author reference	Location	Age	Lung function measure	Effect
Adult				
X	Vaniyambadi, Ambur, Pernampet, Ranipet	35-55	FVC, FEV, FEV_1	-3.0 % per 52 nmol m^{-3} acidity
Y		55-75	FVC, FEV, FEV_1	-3.1% per nmolm^{-3} acidity
Z		Above 75	FVC, FEV, FEV_1	-2.1 % per 34 µg m^{-3} TSP

FVC : forced vital capacity; FEV_1 : forced expiratory volume in one second; TSP: total suspended particles, FEV_{25-75} : forced mild – expiratory volume.

Studies on lung function in children, the age limit upto 12 years during 2006 – 2009 did not observe adverse effect with pulmonary function and higher/lower levels of forced vital capacity (FVC) and FEV_1.[21-23].

There are few cross-sectional studies on lung function conducted among adolescents between the age limit of 35 to 90. About 3% of patients had severe obstruction, 6% had moderate obstruction and 8% had mild obstruction. In contrast, the effects are larger in young males who spent more time outdoors (**Table-1&2.Graph-1).**

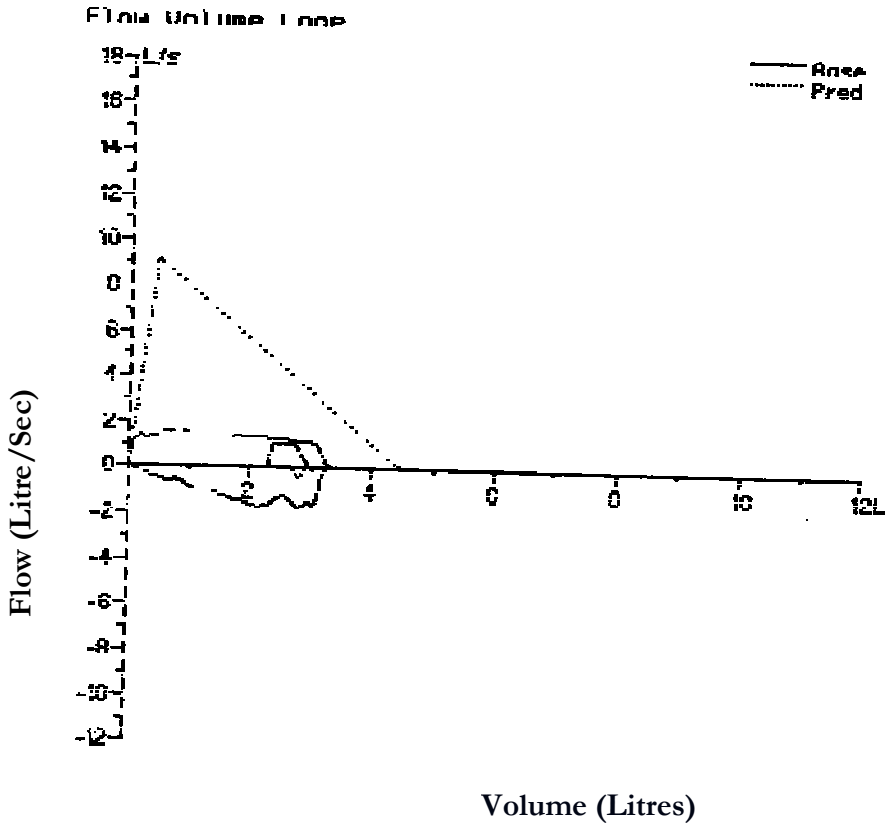
Table 2: Spirometry result of Severe Obstruction

Parameters	Base	Predicted	Minimum observed	Maximum observed	% of predicted
FEV_1	1.54	3.87	3.14	4.60	39
FFV_6	2.91	-	-	-	-
FVC	2.90	4.50	3.58	5.43	64
PFF	9.4	546	323	770	16
FEV_1/FVC	52.9	86.8	73.8	99.8	60
MFF_{75}	1.52	-	-	-	-
MFF_{50}	1.46	5.04	2.77	7.31	28
MFF_{25}	1.33	2.31	1.08	3.55	57
MVV(ind)	57.8	145	118	173	39

Age – 20, Height – 168 cm, Weight – 53 Kg, Sex- Male

FVC : forced vital capacity; FEV_1 : forced expiratory volume in one second, PEFR: peak expiratory flow rate, FEV_{25-75} : forced mild – expiratory volume, MVV: maximum voluntary ventilation.

Graph -1 : Spirometry result of Severe Obstruction



Discussion

There is consistency in the findings that relate the acute increase in urban air pollution and the long–health effects on patients suffering from COPD. Particulate air pollution has been related to increases in daily mortality in general population mainly due to respiratory causes, to increased mortality in patients with COPD, and to higher rates of hospitalization or admission to emergency departments due to COPD on days with elevated pollution.

Studies reveal the increase in symptoms of case of COPD in areas of increased air pollution.[24] WHO expert committee on air pollution[25] concluded that high concentration of SO_2 (150 µgs per m^3) or similar concentration of particulate air pollution measured as black smokes, were associated with increased morbidity in terms of symptoms and hospital admissions in adult patient with COPD – level of SO_2 or black smoke in excess of 500µgs per m^3 would be expected to increase mortality among the elderly and those with the poor cardio pulmonary reserve.

Patients with respiratory disease alone stop exercising at a heart rate below the maximum predicted for their age, since the factor limiting exercise in both obstructive and restrictive disease is the ventilatory capacity. In patients with airways obstruction or restrictive lung disease, the 12 minute walking distance correlates better with FVC than FEV.[26]

Conclusion

The high morbidity among the tannery workers and the dwellers nearby the tanneries are due to the long term exposure to air pollutants such as leather dusts, ozone, chromium, NO_2, SO_2, CO, H_2S and CH_4 evolved from the leather tannery effluents.

This study recommends that the bio-monitoring of air levels of chromium and gases levels at the work place and the nearby surroundings that can be used as a tool for mitigating health hazards and risk factors in the exposed community.

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