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# Ambient air pollution from the leather tanneries in Vellore district in reference to the Asthma

**S. Gnanasekaran *[1], K. Subramani[2] , A.Thaminum Ansari[2]**

*[1] P.G & Research Department of Chemistry, Islamiah College, Vaniyambadi, TamilNadu*
*[2] Department of Chemistry, Government Thirumagal Mills College, Gudiyattam, TamilNadu*

**ABSTRACT**
*This epidemiological study of atmospheric air pollution and incidence of bronchial asthma and the severity from mild to severe was conducted in our asthma clinic at Vellore district covering the areas of Vaniyambadi, Ambur, Pernambut, Vellore and Ranipet. The objective of the study was to identify the air pollutants and their concentrations and their effects such as the mild, moderate and severe forms of bronchial asthma and the prevalence rate among the children, adolescent, adults and old age population during the period of 2006 to 2009. The children were affected 10 – 15%, adolescent about 15% , adults about 20-25% and old age about 8-12% were found .Almost all the persons affected by mild type were reversible to normalcy after inhalation of bronchodilators; severe form of bronchial asthma response to moderate state.50% of severe form of bronchial asthma(status asthmaticus) died during the period of study. Simple test like peak flow meter identified the affected persons and the spirometry study proves the severity.*

**Keywords:** Asthma, COPD, air pollutants, spirometry, severe restriction, peak flow meter.

## INTRODUCTION

This epidemiological study examined the atmospheric pollution and severe diseases created by some leather tanneries waste water treatment and disposal facilities in the Vellore district of Tamil Nadu. Vellore district is a major leather- processing centre in Tamil Nadu, with an estimated 50,000 tannery workers [1,2,3]. The district is the top exporter of finished leather goods in the country. Leather production includes many operations with different exposures, which can be harmful for the health of the tannery workers as well as nearby dwellers because many chemicals used in the tanning processes are considered as probably being carcinogenic to humans[4,5].

The major components of air pollution in developed countries are nitrogen dioxide, sulphur dioxide, ozone and suspended solid or liquid particles. Many organic compounds of industrial origin contribute to airborne public health concerns, as well as environmental problems. High levels of air pollution can adversely affect lung function and triggers asthma and COPD exacerbations. People living in areas with more tanning industries, especially when stagnant air is created by waste water (effluent), are at particular risk [6-10]. A wealth of evidence suggests that allergic respiratory diseases such as rhino sinusitis and bronchial asthma have become more common worldwide in recent years and a great deal of etiologic and pathogenic research has been carried out to evaluate the possible causes of this increasing trend. There is also some evidence that increased atmospheric concentrations of pollutants such as chromium, oxides of nitrogen (NOX), oxides of sulphur (SOX), particulate matter (PM10) and volatile organic chemicals (VOC), which result from leather industry waste water treatment processes and disposal facilities in Vellore district, may be linked to the increased prevalence of allergic diseases which develop more frequently in urban areas of this district.

Since bronchial asthma is a disease which can be aggravated by inhaled compounds, and thereby health effects of air pollutants have received attention. In fact various studies have demonstrated that inhalation of air pollutants such as, chromium, lead,$NO_2$, $SO_2$, $H_2S$ either individually or in combination, can enhance the airway response to inhaled allergens in a topic of subjects inducing asthma exacerbations.

Asthma is characterized by chronic lung disease that inflames and narrows the air ways. The increased air way hyper-responsiveness leading to symptoms of wheeze, shortness of breath, cough, chest tightness and dyspnea. Asthma is a reversible disorder, affects people of all ages, but it most often starts in childhood [11]. About 15% of people in Vellore district are affected by asthma. Males are more affected than Females. Occupational asthma accounts about 5% of adult onset asthma. Asthma cannot be cured, but it can be controlled

Asthma 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. Although acute exacerbations are considered to be the most common cause of hospital admission of asthma patients in age limit between 10 to 65 years and the studies have used the diagnosis labelling stated in medical records. APHEA studies in Europe already showed that a modest increase in asthma admissions related to increases in nitrogen dioxide and sulphur dioxide levels in the atmosphere [12].

Many studies have shown an association between current daily levels of air pollution and daily mortality by respiratory and cardiovascular causes in the general population [13,14]. The purpose of the study was, therefore, to investigate the adverse health effects of exposure to gaseous pollutants such as $NO_2$, $SO_2$, and $H_2S$ including chromium salts from leather tanneries waste water. We assessed the association between daily levels of air pollutants and daily mortality in a cohort of affected patients and diagnosed the mild, moderate and severe restriction and obstruction effects of affected patients in five towns of Vellore district namely Vaniyambadi, Ambur, Pernambut, Ranipet and Walajapet where many leather tanneries located, during the years 2006 to 2009 [15,16].

## EXPERIMENTAL SECTION

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 [16]. A total of 500 people (of the 1000 in the initial cohort) had a diagnosis of asthma, 50 of whom died in the period 2006 to 2009 and were used in analysis.

Daily information on levels of leather dusts, lead, chromium (VI), nitrogen dioxide, sulphur dioxide, hydrogen sulphide, temperature and relative humidity was collected from tannery accumulated places in Vellore district, which include Vaniyambadi, Ambur, Pernambut, Ranipet and Walajapet during the year 2006-2009[14] (Table 1 & 2).

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[17] and adding the natural logarithm of the number of patients who are still alive. To evaluate dyspnea and determine the estriction of the affected asthma 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 quarz microfiber filters (Whatman 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, dermatological 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. Detection of Chromium levels in Human blood and Urine samples**
The blood chromium levels and lung functions of the tannery workers and nearly dwellers who are potential candidates for chromium inhalation. The hospital staff served as control group. The measurements of chromium and lead levels were performed using atomic absorption spectrophotometry. We observed that blood chromium levels of the tannery workers, nearby dwellers and controls were found to be 1.424 mg/L, 0.983 mg/L, 0.0134 mg/L, and 0.0096 mg/L respectively and the urine chromium levels were found to be 35 – 45 µg /L, and 25-35 µg /L, and 4.5 – 12.5 µg /L respectively.

**6. Detection of Lead levels in Human blood and Urine samples**

The blood lead levels of the tannery workers, nearby dwellers and controls were found to be 23 µg/dL, 20 µg/dL, 10 µg/dL, and 1-5 µg/dL respectively and the urine lead levels were found to be 38 µg /L, 28 µg /L and 1 – 5 µg /L respectively.

**7. Bronchodilator reversibility test**

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

**8. 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.

**9. 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.

**10. ECG testing**

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

## RESULTS

All studies consistently found a higher prevalence of symptoms of breathlessness or asthma in areas with higher particulate air pollution due to evolution of higher percentage of leather dusts, chromium, lead, $NO_2$, $SO_2$, and $H_2S$ from the tannery waste water. Studies on daily admissions in emergency rooms and hospital admissions were specific for asthma conducted during the 2006 to 2009 in five towns in vellore district namely Vaniyambadi, Ambur, Pernambut, Ranipet and Walajapet, where more tanneries located have consistently observed that admissions due to asthma increased on days with high pollution values. The association of particles and gaseous pollutants were higher in nearby tannery areas and slowly decreased in faraway places from leather tanneries.

**Table -1: Detection of Ambient air quantity in near leather tannery area during Summer season ( 12 hours)**

| **Parameters** | **Ambient air(microgram/m$^3$)** | **National ambient air quality standards as per Schedule VII (Nov.2009)(24 hrs) (microgram/m$^3$)** |
|---|---|---|
| Concentration of Non Respirable Suspended Particulate Matter(NRSPM) | 156.00 | Not Available |
| Concentration of Non Respirable Suspended Particulate Matter[size less than 10 µm] (RSPM) | 107.50 | 100 |
| Concentration of Sulphur-di-oxide($SO_2$) | 22.11 | 80 |
| Concentration of Oxides of Nitrogen ($NO_2$) | 54.60 | 80 |
| Concentration of Hydrogen Sulphide ($H_2S$) | 2.0 | 85 |
| Chromium | BDL (D.L-0.5) | Not specified |

*BDL : Below detection Level , D.L : Detection Level, Ambient Temperature : 29º C, Relative Humidity : 70%*

**Table -2: Detection of Ambient air quantity in near leather tannery area during Summer season (24 hours)**

| Parameters | Ambient air(microgram/$m^3$) | National ambient air quality standards as per Schedule VII (Nov.2009)(24 hrs) (microgram/$m^3$) |
|---|---|---|
| Concentration of Non Respirable Suspended Particulate Matter(NRSPM) | 256.00 | Not Available |
| Concentration of Non Respirable Suspended Particulate Matter[size less than 10 µm] (RSPM) | 209.50 | 100 |
| Concentration of Sulphur-di-oxide($SO_2$) | 45.10 | 80 |
| Concentration of Oxides of Nitrogen ($NO_2$) | 102.20 | 80 |
| Concentration of Hydrogen Sulphide ($H_2S$) | 4.2 | 85 |
| Chromium | BDL (D.L-0.5) | Not specified |

*BDL : Below detection Level , D.L : Detection Level, Ambient Temperature : 29º C, Relative Humidity : 70%*

**Table- 3: Cross sectional and cohort epidemiological studies on lung function and air pollution**

| Author reference | Location | Age | Lung function measure | Effect |
|---|---|---|---|---|
| **Cross sectional studies** | | | | |
| Children | | | | |
| X | Vaniyambadi, Ambur, | 5-8 | FVC, FEV, $FEV_1$ | No association |
| Y | Pernambut, | | | |
| | Ranipet, | 8-12 | FVC, FEV, $FEV_1$ | -1.5 per 6 µg. $m^{-3}$ sulphates |
| Z | Walajapet. | | | |
| | | 10-15 | FVC, FEV, $FEV_1$ | -1.1 per 6 µg. $m^{-3}$ sulphates |
| Adult | | | | |
| X | Vaniyambadi, Ambur, | 35-55 | FVC, FEV, $FEV_1$ | -2.5 % per 52 nmol $m^{-3}$ acidity |
| Y | Pernambut, | | | |
| | Ranipet, | 55-75 | FVC, FEV, $FEV_1$ | -2.8 % per 52 nmol $m^{-3}$ acidity |
| Z | Walajapet. | | | |
| | | Above 75 | FVC, FEV, $FEV_1$ | -1.8% per 34 µg $m^{-3}$ TSP |
| **Cohort studies** | | | | |
| | | 8-10 | | |
| X | | | ? $FEV_1$ | -0.027 mL $day^{-1}$ per ppb of $SO_2$ |
| | Vaniyambadi, Ambur, | 10-12 | | |
| Y | Pernambut, Ranipet, | | ? $FEV_1$ | -0.029 mL $day^{-1}$ per ppb of $SO_2$ |
| | Walajapet. | 35-75 | | |
| Z | | | ? $FEV_1$ | -22.5 and -8.6 mL $yr^{-1}$ in males and females |

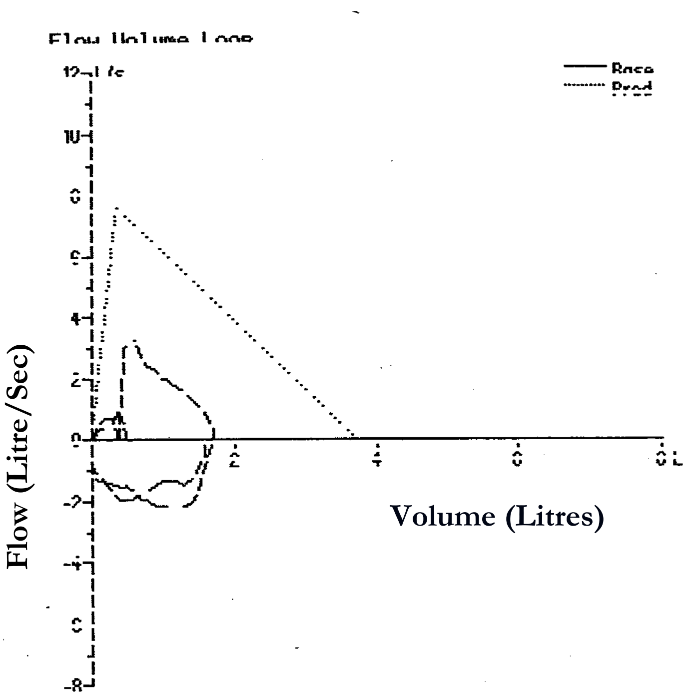
*FVC: forced vital capacity; $FEV_1$ : forced expiratory volume in one second, TSP: total suspended particles, $FEV_{25-75}$ : forced mild – expiratory volume.*

**Table- 4. Spirometry result of Severe Restriction**
**Age – 30, Height – 168 cm, Weight – 53 Kg, Sex- Male**

| 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 |

*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 Restriction**




## DISCUSSION

All epidemiological studies consistently found a higher prevalence of symptoms of breathlessness or asthma, in areas with higher particulate air pollution due to evolution of higher percentage of leather dusts, chromium, $NO_2$, $SO_2$, $H_2S$ and particulate matter from the leather tannery waste water exhaustion. The daily number of asthma and COPD admissions varied from 1 (Ambur, Pernambut and Walajapet) to 5 (Vaniyambadi and Ranipet). The proportion of Asthma, admissions for patients aged $\geq$ 10 to 65 years ranged from 10 % in Ambur, Pernambut, Walajapet, to 25 % in Vaniyambadi and Ranipet.

The association of particles and gaseous pollutants were higher in nearby tannery areas and slowly decreased in far away places from these industries. 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, lead, $NO_2$, $SO_2$, and, $H_2S$ evolved from the leather tannery effluents.

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

WHO expert committee on air pollution [20] 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 asthma patient with the levels 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.

## CONCLUSION

Ambient air pollution has important and diverse health effects, in leather tannery areas. Currently, levels of chromium, lead, $NO_2$, $SO_2$, $H_2S$ and particulates in infants, children's and adults are among the most susceptible, especially, those in who were living around leather tannery and particulates remain unhealthful in many parts of the Vellore district of Tamil Nadu, where the current National Ambient Air Quality Standards may not protect the public adequately. There is a compelling need to move forward on efforts to ensure clean air for all. Chemical gaseous pollutants levels tend to be highest in the afternoon and it may be possible to decrease children and adult's exposure by scheduling strenuous outdoor activity earlier in the day. Those who were having higher concentration of chromium levels in blood and urine were having severe form of bronchia asthma and there were no neurological deficit as the leaf levels were below the toxic levels.

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.

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 $FEV_1$ [21-24].

Physicians who serve as informers for leather tannery workers and people who are living near tannery areas, or for daily walking should be aware of the health implications of pollution alerts to provide appropriate guidance to children and adults, particularly in communities with high levels of ambient air pollutants.

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