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# Pulmonary Function Changes Among Matchbox Workers in Sivakasi

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**ABSTRACT**

**BACKGROUND**
Majority of population of Sivakasi being matchbox workers are exposed to various chemicals like potassium chloride, sulphur, antimony triphosphate and many others which may cause respiratory disorder on exposure. These disorders may cause variation in pulmonary function. Thus the study was planned to analyze the pulmonary function changes among matchbox workers in Sivakasi population.

**MATERIALS AND METHOD**
About 300 matchbox workers from Sivakasi district where included in the study involving both gender under the age group 30-70 years. The PFT procedure was explained and written consent form was obtained from all the subjects in their language and none of them were forced to participate in the study. People fitting into our inclusion criteria were analysed in the study.

FVC,FEV1, FVC/FEV1, FEF 25%, FEF 50%, FEF 75% where analyzed using portable RMS Helios 701 at Sivakasi. Institutional Ethical clearance was obtained from MAHER University before starting the project. The best values obtained from the study was entered for each subject . The values were analysed using software SPSS version 21.0.

**RESULTS**
On comparing the observed and predicted values and also the abnormal PFT with duration of exposure , there was a significant reduction in the lung function. The pulmonary findings showed a marked decrease in FVC, FEV1/FVC, FEV1, FEF25%, FEF50%, FEF75% when compared to normal values. This study showed that 29.7% had normal lung function, 26.3% with restrictive disorder, 20% with obstructive disorder and 24% with mixed type of blockage.

**CONCLUSION**
The Pulmonary function parameters of match factory workers showed marked respiratory alteration due to improper handling and chronic usage of chemicals. This may have lead to significant decrease in pulmonary function test values which can be reduced by proper handling of chemicals with suitable protective measures.

***KEYWORDS; Matchbox workers, occupational exposure, occupational lung disease, Pulmonary function test, restrictive and obstructive pattern.***

## 1. INTRODUCTION

A broad spectrum of adverse health effects are seen with various occupational setting(1).Those range from mild reversible conditions to progressive disorders which mostly affect respiratory system.

These cause pulmonary disorders like coal workers pneumoconiosis, chronic obstructive pulmonary disease (COPD), asbestosis, mesothelioma which may be due to the rate and duration of exposure to various occupational hazards(2-4).

The world wide incidence of pneumoconiosis and other occupational respiratory diseases have been estimated at 4,53,000 and 26,31,000 cases per year (5). Sivakasi is known as “Mini Japan” for its match production, and other factories. Match stick industries are one of the major industries in Sivakasi (6). Majority of the match stick are produced from Kerala and Tamil Nadu in which Sivakasi contributes about 70% of the total match production in India . There are about 53 match factories in Sivakasi which employs more than 2000 workers (7).

In these match factories the employers are engaged in various activities and work for about 8 - 10 hours per day. These workers are exposed to various hazards like phosphorus, asbestos, lead, sulphuric acid, sulphur, antimony triphosphate and potassium chloride (8).

One of the major chemical used is phosphorus. Exposure to phosphorus for such a long time form calcium phosphorus in the skeleton and leads to phosphorus poisoning contributing to “phossy jaw” and even osteoarthritis of lower jaw.
White phosphorus used in match factories have developed physical ailments. Inhalation of phosphorus fumes cause inflammation of lungs and leads to other pulmonary problems. Too much of phosphorus inhalation may cause fluorescent vomit, bluish breath and glow around their mouth (9).

Asbestos is the name given to a series of materials composed of fibrous silicate of magnesium and iron which find a widespread use in match factory. Inhalation of the asbestos dust may cause asbestosis, a crippling form of pulmonary fibrosis, which usually does not appear until many years after initial exposure. There is also an increased incidence of carcinoma of lung in patients with asbestosis (10).

Lead is a heavy metal that remains as an industrial pollutant (11-12).It may contribute in pathogenisis of pulmonary cancers, chronic obstructive pulmonary disease (COPD) and occupation induced asthma (13-14).

Particulate sulphate, including sulphuric acid are component in match production where they are used in chemical powder for match head preparation. Exposure to sulphuric acid causes bronchconstriction leading to occupation induced asthma(15-16).

In general, inhaled particles get stuck within the lung and causes lung irritation, mucus hypersecretion, lung function impairment along with skin and eye irritation. Chronic inhalation leads to lung inflammation, COPD and even lung cancer (17).

Most of these workers being uneducated are not aware about these occupational health hazard and work without any safety measures. Despite the presence of unorganized sectors, Social Security Act (2008), this sector gets no social security measures (18).

Even though technology has improved and match production are made mechanized, there are many small scale match factories in Sivakasi employing workers for match production. During match production they are exposed to various hazards which may lead to several respiratory disorders.

Most of these workers being not educated are about these harmful effects, do not use any protective measures. Though they earn very less, few prefer working in such conditions so as to serve as bread winner for their family.

There is less focus about the match factory workers especially in Sivakasi. Thus the study was done to analyze and understand harmful effects on health and create awareness on pulmonary function changes in these workers and enforce them to use suitable protective measures.

## 2. MATERIALS AND METHODS

### STUDY AREA

This study was carried out in town Sivakasi of Virudunagar district, Tamil Nadu, India. The subjects were analysed from various small scale match factories both registered and non registered. These workers were engaged in various works like match stick production, matchbox production and production of chemicals for match head. They are engaged in work for 8 - 10 hours per day and are exposed to various chemical hazards throughout the work period.

### STUDY DESIGN AND STUDY POPULATION

A descriptive cross sectional study was done. 300 matchbox workers in Sivakasi, who were for more than 5 years in those match factories were analyzed in this study.

### INCLUSION CRITERIA

- Age limit: 30 - 70 years
- Working for more than 5 years in match factories
- Both gender of match production workers

### EXCLUSION CRITERIA

- Present or past smoker
- Workers with known respiratory problems
- Subjects who are not willing to participate in the study

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Using interview technique, data was collected in pre designed and pre tested pro-forma. They were interviewed with regard of demographic data, smoking habit, duration of exposure, type of work, any ailments and respiratory symptoms. They were also enquired about their awareness of health problems and usage of safety equipment at work place. After taking a detailed history, general examination was done. Vitals were recorded, detailed cardio vascular system and respiratory system examination was done. All the data was entered in a separate case sheet for each subject.

**INSTRUMENTS USED**

Portable RMS Helios 701, Peak Flow Meter, were used for analysis.

**ETHICAL CONSIDERATION**

Ethical clearance for the study was obtained before starting the study from institutional ethical committee MAHER University research ethical committee.

Informed and written consent form was obtained from the workers in their language after detailed explanation of the procedure and then the study was done.

Disposable mouth piece with suitable precautions as per equipment specification of American Thoracic Society was used during the study.

**PROCEDURE**

All the subjects were made familiar with the instrument and the pulmonary function test procedure. The test was done on the subjects in comfortable upright position. The workers were asked to hold the instrument in upright position. They were first asked to breath in, and enclose there mouth in the mouthpiece, in order to make them familiar about the procedure. During the test, the subjects were adequately encouraged to perform at their optimum level.

To perform the pulmonary function test, the subjects were instructed to breath in deeply to their maximum first. Then transducer with the disposable mouth piece attached was placed in the mouth of the subject and were asked to expel air out to the maximum. Once completing the expulsion, they were asked to breath in quickly as possible, placing their mouth in the transducer until full lope is obtained.

This was repeated up to three times, and the best values of forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR), ratio of forced expiratory rate in one second and forced vital capacity (FEV1/FVC), forced expiratory flow 25 to 75 percent (FEF 25 -75 %) and lung age was measured for each worker.(19)

**STATISTICAL ANALYSIS**

The statistical analysis was done using software SPSS version 21.0 . Paired ‘t’ test for means, One Way Anova were used for analysis.

**3. OBSERVATIONS AND RESULTS**

Table 1: Comparison of observed and predicted pulmonary function values

| PARAMETERS | PREDICTED | OBSERVED | P- VALUE |
|---|---|---|---|

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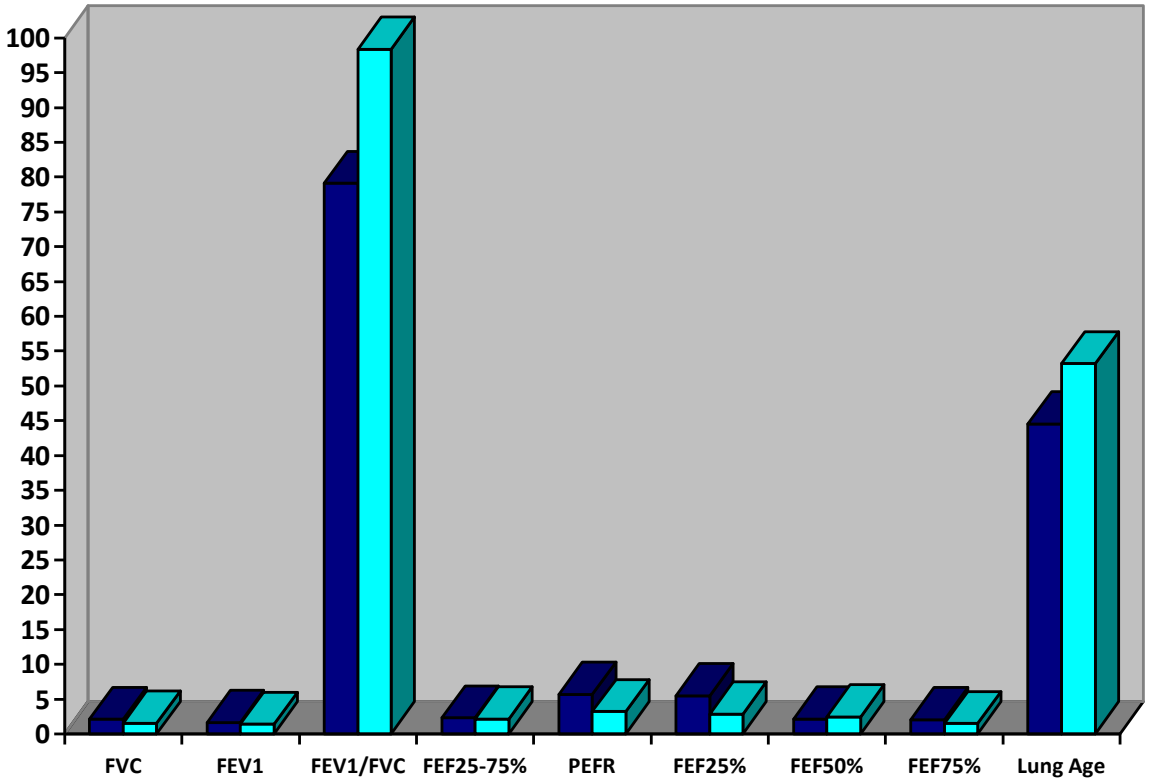
| | | | |
|---|---|---|---|
| FVC | 2.0862 | 1.5469 | 0.00 |
| FEV1 | 1.6620 | 1.374 | 0.00 |
| FEV1/FVC | 79.0837 | 98.4835 | 0.51 |
| FEF 25- 75% | 2.3696 | 2.1517 | 0.00 |
| PEFR | 5.7203 | 3.2061 | 0.00 |
| FEF 25% | 5.5876 | 2.8502 | 0.00 |
| FEF 50% | 2.1341 | 2.4271 | 0.00 |
| FEF 75% | 2.0305 | 1.4902 | 0.00 |
| LUNG AGE | 44.55 | 53.27 | 0.00 |

Table 1 shows the predicted and observed pulmonary function values of match workers that are expressed in mean. On comparison with predicted and observed values, the parameters FVC, FEV1, FEF 25-75%, PEFR, FEF25%, FEF50%, FEF70% and Lung age had a significant reduction.




GRAPH 1

Table 2: Distribution of subjects with respect to years of work and abnormal finding

| PARAMETERS | 5-15 YEARS N = 300 MEAN | 16-25 YEARS N = 300 MEAN | 26-35 YEARS N = 300 MEAN | 35-45 YEARS N = 300 MEAN | P-VALUE |
|---|---|---|---|---|---|

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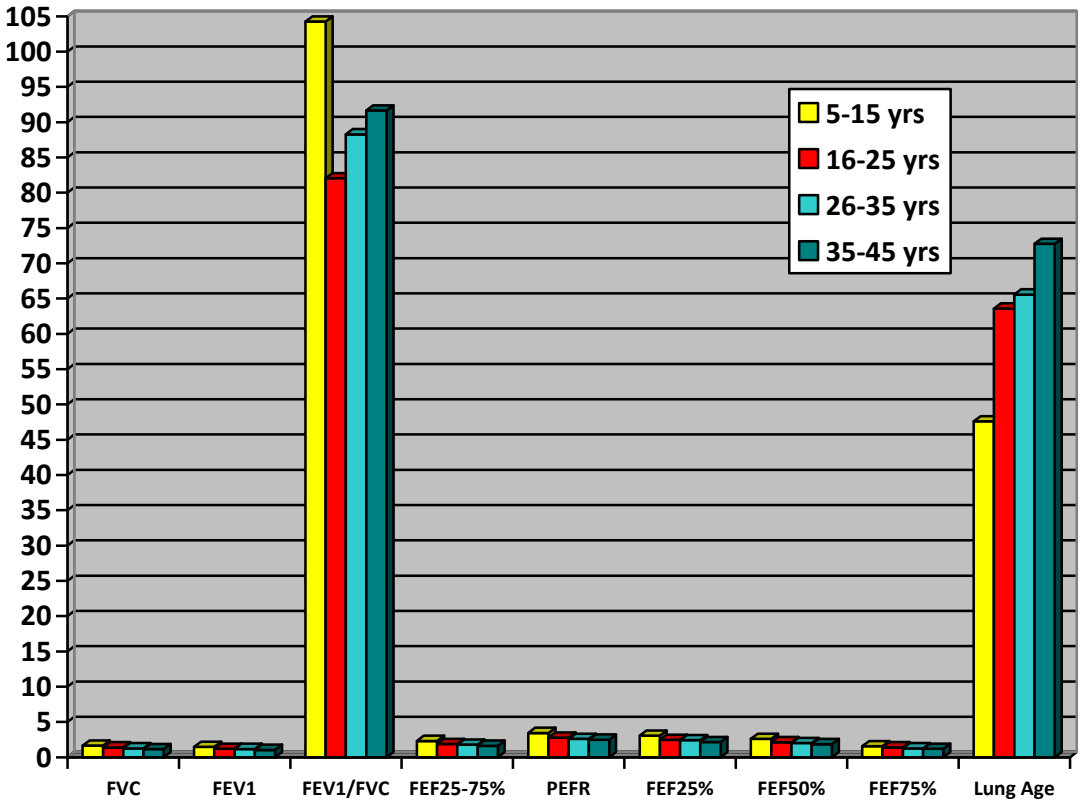
| | | | | | |
|---|---|---|---|---|---|
| FVC | 1.64 ± 0.04 | 1.40 ± 0.06 | 1.27 ± 0.13 | 1.14 ± 0.09 | 0.001 |
| FEV1 | 1.46 ± 0.04 | 1.20 ± 0.07 | 1.17 ± 0.15 | 1.04 ± 0.10 | 0.002 |
| FEV1/FVC | 104.25 ± 14.5 | 82.05 ± 2.86 | 88.28 ± 5.38 | 91.65 ± 4.88 | 0.866 |
| FEF 25-75% | 2.306 ± 0.73 | 1.87 ± 0.12 | 1.78 ± 0.29 | 1.62 ± 0.17 | 0.003 |
| PEFR | 3.44 ± 0.10 | 2.77 ± 0.16 | 2.61 ± 0.37 | 2.48 ± 0.28 | 0.001 |
| FEF 25% | 3.05 ± 0.10 | 2.47 ± 0.17 | 2.43 ± 0.40 | 2.14 ± 0.27 | 0.007 |
| FEF 50% | 2.59 ± 0.07 | 2.12 ± 0.13 | 2.02 ± 0.31 | 1.85 ± 0.23 | 0.002 |
| FEF 75 % | 1.55 ± 0.05 | 1.39 ± 0.08 | 1.27 ± 0.12 | 1.20 ± 0.16 | 0.089 |
| LUNG AGE | 47.61 ± 1.30 | 63.59 ± 2.91 | 65.57 ± 6.57 | 72.77 ± 4.22 | 0.000 |




GRAPH 2

As the duration of work in years increased, the percentage with abnormal lung function also increased and was found to be statistically significant. These are expressed in mean. This is shown in table 2.

There is increased respiratory abnormality in 5 to 15 year exposure match worker population.

Table 3: Prevalence of respiratory disorders among 300 subjects

| PFT PARAMETERS | NO.OF PARTICIPANTS | PERCENTAGE |
|---|---|---|
| Normal | 89 | 29.7% |
| Restrictive | 79 | 26.3% |
| Obstructive | 60 | 20% |
| Mixed Blockage | 72 | 24% |

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The table 3 shows the types of respiratory disorder among the population of 300 matchbox workers in Sivakasi. It showed 89 people with normal lung function(29.75), about 79 with restrictive type of disorder(26.3%), those with obstructive disorder were 60 ie.,(20%) and 72 with mixed type of blockage(24%).

## 4. DISCUSSION AND CONCLUSION

In the present study, the pulmonary function test parameters like FVC, FEV1, FEF 25-75%, PEFR, FEF25%, FEF50%, FEF75%, Lung age showed significant difference. Occupational environmental exposure to match box industry affects human health, which may lead to respiratory health problems. Exposure to harmful chemicals can cause various acute and chronic respiratory diseases including respiratory function damage.

Classic epidemiological studies revealed chronic chemical exposure is the major risk factor for Chronic Obstructive Lung Disease, while the recent clinical and pathological experimental studies have contributed further towards elucidating the pathophysiological mechanism by which chemicals can cause alteration that may lead to the development of pulmonary diseases.

The chemicals used in match stick industry on long duration of exposure may enter the lung, get lodged and cause lung irritation, hypersecretion of mucus, inflammation of lung parenchyma which may lead to decreased lung function parameters leading to either chronic obstructive or restrictive lung disease (19).

According to the result, there was a significant decrease in pulmonary capacity which could be due to interleukins, tissue necrosis factor alpha. These act by producing systemic inflammation that adversely affect the pulmonary function of match box workers (20 -21).

The chemicals which are used in matchbox industries, fine dust particles produced from covers, box of match sticks may float in their vicinity due to various activities in factory enter into the respiratory passage through nose, trachea leading to chronic respiratory disease and reduction of ventilator capacities. Previous studies have shown increased respiratory symptoms among workers of different category supporting the result of the present study (22- 23).

The matchbox workers in our study showed altered pulmonary function test, since these people rarely or do not use any protective measures like gloves, face mask. Handling of these chemicals without proper precaution may lead to adverse effects on respiration and reflected as decreased pulmonary parameters. The result observed from the study also showed both restrictive and obstructive impairment of lung function.

The pulmonary function parameters of match factory workers in Sivakasi population showed marked respiratory alteration because of improper handling and chronic usage of chemicals. This has lead to

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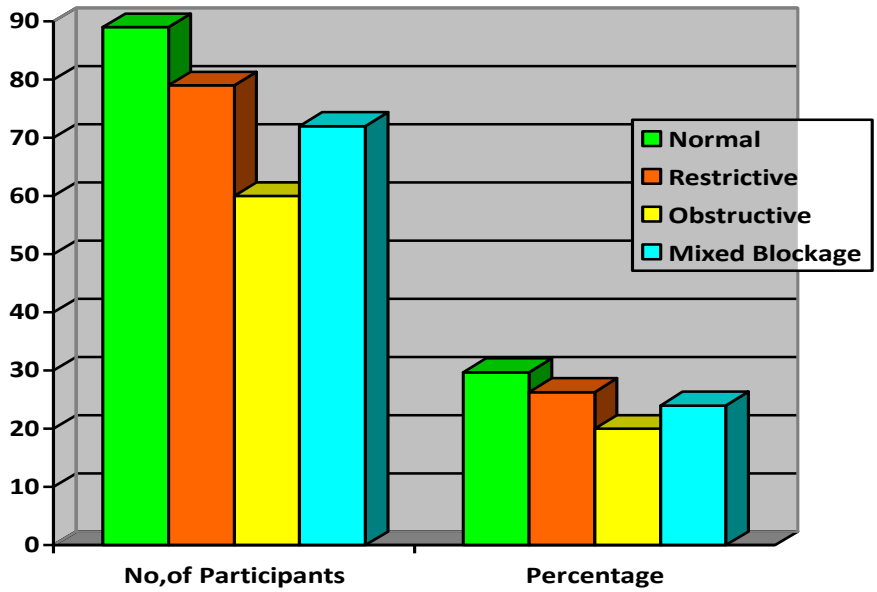
significant change in pulmonary function test which can be prevented by proper handling of chemicals; usage of protective measures like gloves, face mask and awareness regarding chemical usage. This may improve the life style pattern of match workers in Sivakasi.




GRAPH 3

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