

## Lung function assessment by spirometry among distillery factory workers

SudhakarPari<sup>1</sup>, Vadivel Sambasivam<sup>2</sup>

<sup>1</sup> Assistant Professor, Department of Physiology, Chengalpattu Medical College, <sup>2</sup> Professor and Head, Department of Physiology, Karpaga Vinayaga Institute of Medical Sciences, Palayanoor, Kanchipuram, Tamilnadu

### Abstract

**Background:** Exposure to vapors and gases like CO (Carbon monoxide), NO<sub>2</sub> (Nitrogen oxide) and HCN (Hydrogen cyanide) released throughout the production of distilled spirits is a possible hazard. During the fermentation process, several refrigerant gases released may be toxic and can lead to harmful effects on respiratory functioning. **Aim and objectives :** The aim of this study was to compare the lung function of workers with direct and indirect exposure to distillery and fermentation process assessed by spirometry. The objective is to compare the lung function with duration of exposure to distillery process among distillery workers in Maduranthagam. **Materials and Methods:** This was an observational study carried out in distillery factory workers who attended outpatient department of physiology in a tertiary care hospital in 2016 for health checkup including pulmonary function test. PFT was done using Medicaid spirometry. Total of 67 samples were chosen for the study. All Factory workers were females of age from 19 yrs. to 33 yrs grouped into two groups based on type of exposure to distillery plant. Among them 40 had direct exposure (those working in distillery plant) and 27 had indirect exposure (those not working in distillery plant). Anthropometric measurements were taken for both groups before the assessment of PFT. The spirometric parameters that were taken for study were FVC (Forced Vital Capacity), FEV<sub>1</sub> (Forced Expiratory Volume in first second), FVC/FEV<sub>1</sub>% and PEF (Peak Expiratory Flow Rate). **Results:** Direct exposure group had significant reduction in FVC, when compared to indirect exposure group. FEV<sub>1</sub> values were marginally reduced in direct exposure group. There was no significant difference in FEV<sub>1</sub>/FVC% and PEF value among the two groups. Mean duration was more in direct exposure. **Conclusion:** There are only few studies on the respiratory effects of different processes in distillery brewery manufacturing. We found that distillery factory workers engaged in distillery plants were at risk of pulmonary function impairment, which might be related to gases, vapours and chemical exposure. Our study results have called for attention to the exposure to distillery plants among workers engaged in distillery factories.

**Keywords:** distillery, pulmonary function test, spirometry

### Corresponding Author

Dr. Vadivel Sambasivam, Professor and Head, Department of Physiology, Karpaga Vinayaga Institute of Medical Sciences, Palayanoor, Kanchipuram, Tamilnadu - 603308  
Telephone: +91 9444057227E-mail: drsvadivel2012@gmail.com

### Introduction

The beverage industry consists of two major categories and eight sub-groups. The non-alcoholic category is comprised of soft drink manufacture

which includes soft drink, water bottling, canning and boxing, the coffee industry and the tea industry. Alcoholic beverage category includes distilled spirits, wine and brewing. The beverage industry employs several million people

worldwide, and each type of beverage grosses billions of dollars in revenue each year.<sup>1</sup>

Distilled spirits can be produced from many numbers of materials, such as fermented mashes of cereal grains, sugar cane juice, fermented fruit juices, molasses, honey and cactus juice. Fermentation for making wine and beer can be traced back to between 5000 and 6000 BC. However, the history of distillation is much more recent. Although it is uncertain where distillation originated, it was known to alchemists and began to spread in use throughout the thirteenth and fourteenth century. Early uses were primarily pharmaceutical.<sup>2</sup>

Alcoholic beverages are divided into two groups, depending on their mode of preparation: fermented beverages, such as wine and beer, and distilled beverages, such as whisky and brandy. Liqueurs are basically prepared by blending juices or extracts of fruits, nuts or other food products.<sup>2</sup>The phases of activity in distilled spirits production include receiving of grain, milling, cooking, fermentation, distillation, storage, blending and bottling. <sup>2</sup>Exposure to vapours and gases like CO (Carbon monoxide), NO<sub>2</sub> (Nitrogen oxide) Cl<sub>2</sub> (Chloride), sulphur dioxide (SO<sub>2</sub>), hydrogen sulphide (H<sub>2</sub>S), ammonia (NH<sub>3</sub>) and (CH<sub>4</sub>) and HCN (Hydrogen cyanide) released throughout the production of distilled spirits is a possible hazard. During the fermentation process, several refrigerant gases like chlorofluorocarbon (CFC) and hydro chlorofluorocarbon (HCFC) released may be toxic. Hazardous materials such as varsol (mineral spirit), caustics, acids and many other solvents and cleaners are used throughout the facility.<sup>2</sup>

For the production of 1 liter of alcohol 3-10 kgs of molasses are utilized.<sup>2</sup>A large network of distilleries has been established in India to utilize molasses, which are regarded as one of the most polluting agro-based industries emitting huge quantities of distillery spent wash (DSW).<sup>3</sup> Occupational exposure to Vapours, refrigerant gases and organic solvents might cause chronic airway impairment with nonspecific bronchial hyper responsiveness.

Pulmonary function test is one of the basic and essential tests for diagnosis and assessment of pulmonary diseases such as pulmonary dysfunction, chronic obstructive pulmonary disease (COPD) and asthma. <sup>4</sup>Pulmonary function tests (PFTs) are tools used in the diagnosis of lung disease. These tests can often identify problems early in the course of disease, sometimes before physical examinations or chest X-rays.<sup>2</sup>

### Aim and objectives

The aim of this study was to compare the lung function of workers with direct and indirect exposure to distillery and fermentation process assessed by spirometry. The objective is to compare the lung function with duration of exposure to distillery process among distillery workers in Maduranthagam.

### Materials and Methods

This was an observational study carried out in distillery factory workers attending outpatient department of physiology, tertiary care hospital in 2016 for health checkup including pulmonary function test. Ethical clearance obtained from Ethical Committee. PFT done using Medicaid spiro excel spirometry. Out of 80 workers, total of 67 workers were chosen for the study. Employees with unsatisfactory efforts were removed from the study. All Factory workers were females of age ranging from 19 yrs to 33 yrs, divided into two groups depending upon type of exposure to distillery plant as mentioned in Fig 1 and 2.

Among them 40 had direct exposure (those working in distillery plant) and 27 had indirect (those not working in distillery plant). Anthropometric measurements were taken for both groups before the assessment of PFT. The spirometric parameters taken for study were FVC (Forced Vital Capacity), FEV<sub>1</sub> (Forced Expiratory Volume in first second), FVC/FEV<sub>1</sub>% and PEFR (Peak Expiratory Flow Rate).

**Inclusion criteria**

1. Workers who had no history of present acute /previous chronic respiratory illness
2. Duration of exposure 8 h a day for more than 1 year.

**Exclusion criteria**

1. Those who had not done the test as per acceptability and repeatability criteria.
2. Workers who had respiratory disease prior to employment.

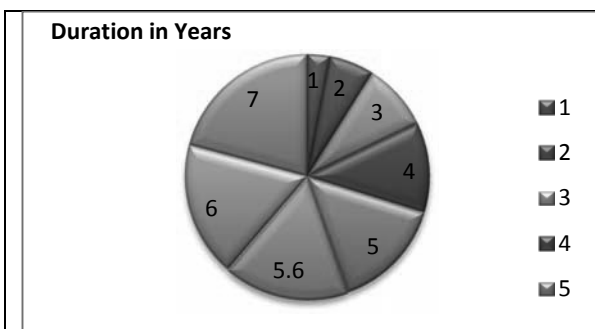


Fig 1: Duration of exposure in years to Distillery Plant

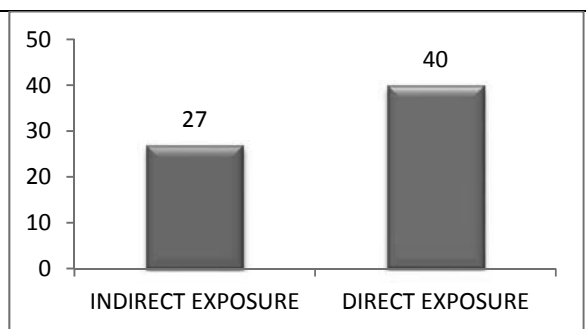


Fig 2: No of Workers with Direct and Indirect exposure to Distillery plant

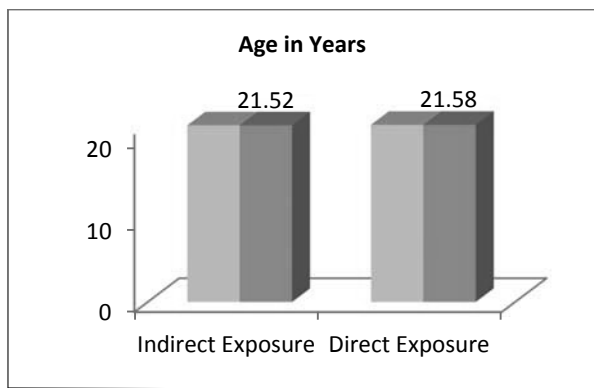


Fig 3:Age Comparison between two groups in yrs

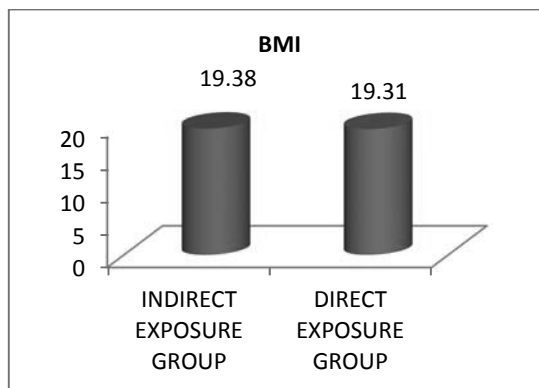


Fig 4: Comparison of BMI between groups

**Statistical analysis**

Data was analyzed by SPSS 20V. FVC, FEV1, FEV1/FVC% and PEFr values analyzed by mean, median and Standard Deviation. Groups were compared by student "t" test at 5% level of significance.

**Results**

Out of the 80 candidates examined, 47 had direct exposure (those working in distillery plant) and 33 had indirect exposure (those not working in distillery plant). However, 7 direct exposure workers and 6 indirect exposure worker were excluded due to presence of respiratory disease and unsatisfied effort during the spirometry test. The final study population of 40 direct exposure

distillery factory workers and 27 indirect exposure distillery factory workers (the comparison group) had similar age and sex indicating successful

matching(Fig 3). The two groups also had similar height, weight and BMI with  $P > 0.05$  (Fig 4).

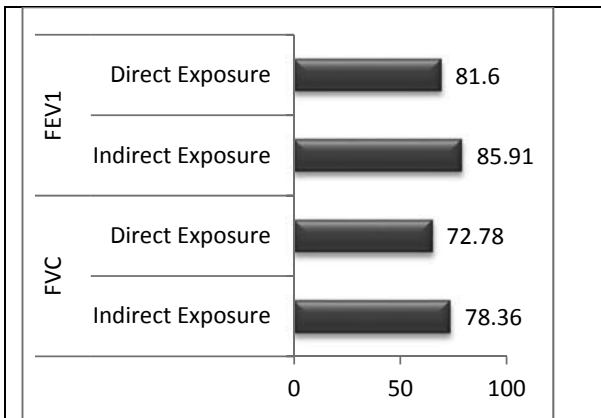


Fig 5: Comparison of Predicted% of FEV<sub>1</sub> and FVC values in between the groups

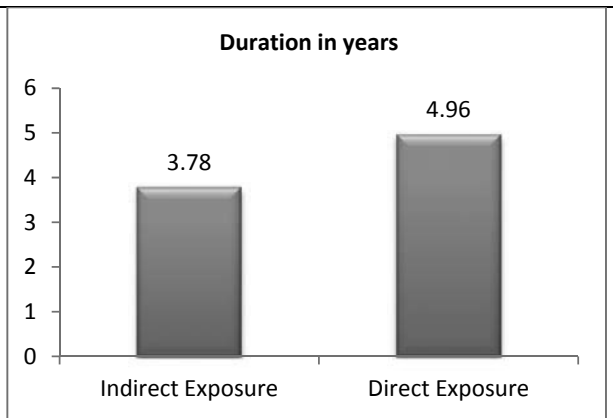


Fig 6: Comparison of duration of exposure in years between the groups

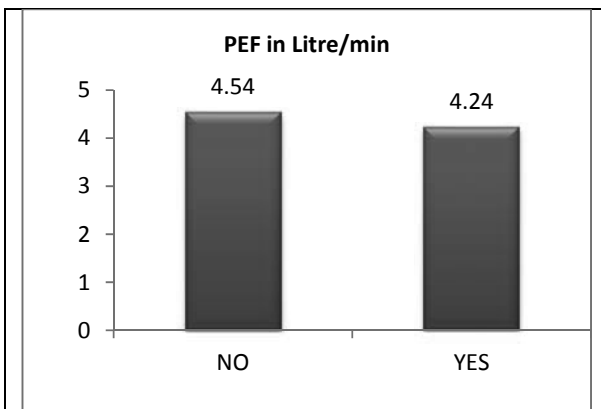


Fig 8: Comparison of PEFR between the groups

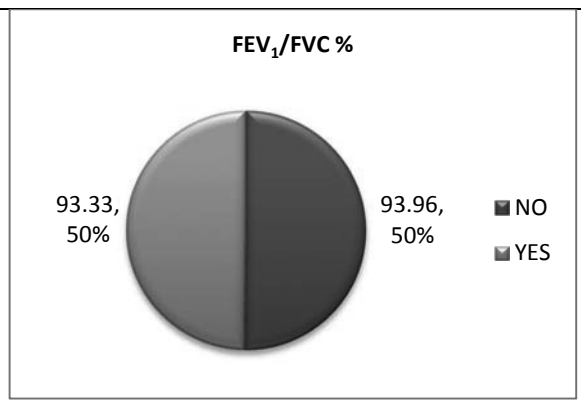


Fig 9: Comparison of FEV<sub>1</sub>/FVC % values between groups

Direct exposure group had significant reduction in FVC with  $P < 0.001$ , When compared to indirect exposure group. FEV<sub>1</sub> values were marginally reduced in direct exposure group with  $P < 0.05$  but it is within normal range, there is no significant difference in FEV<sub>1</sub>/FVC% and PEFR values among the two groups. Mean duration is more in direct exposure.

**Discussion**

Among distillery factory workers, significant decline was observed in FVC, FEV<sub>1</sub> but not FEV<sub>1</sub>/FVC and PEFR. The abnormal pulmonary function tests we observed were restrictive changes. Therefore, further studies should be conducted to evaluate if long-term exposure to distillery plants can lead to restrictive changes. The multiple regression analysis showed that age and height were

independent predictors of pulmonary function, which is a well-documented fact. In our study, age and height of the workers is matched well. The results indicate that there is a significant toxic effect of solvents and air pollutants on workers working in a distillery factory. Direct Exposure group is more affected than indirect exposure group. When the duration is more chances of direct exposure is more.

According to Nwadinigwe et al (2015), concentration of CO, NO<sub>2</sub>, and Cl<sub>2</sub> detected in production hall, chlorination tank area and water treatment area were significantly ( $P < 0.05$ ) higher than those detected from other locations. In comparing the concentrations of gaseous emissions detected from the brewery and bottling companies, CO and HCN detected from Brewery was significantly higher than that detected from Bottling Company. Cl<sub>2</sub> detected from Bottling Companies was significantly ( $P < 0.05$ ) higher than that detected from Brewery.<sup>11</sup>

Further studies with larger numbers of participants that allow stratification of exposure to distillery plant in greater details are warranted to better evaluate the effect of exposure to distillery plant. The current study showed that exposure to distillery plant, could lead to the impairment of pulmonary function. Therefore, proper preventive or control measures should be done like personal respiratory protection such as simple disposable masks should be applied. Workers may also benefit from health surveillance and educational programs adopted. Annual health examinations should include pulmonary function tests and chest X-ray, for workers with exposure to distillery plants.

### Conclusion

There are few studies on the respiratory effects of different processes in distillery brewery manufacturing. We found that distillery factory workers engaged in distillery plants are at risk of pulmonary function impairment, which might be related to gases, vapours and chemical exposures throughout the process of distillery production. Whereas further studies with longitudinal follow-up designs and larger samples are warranted to

confirm our findings, our study results have called for attention to the exposure to distillery plants among workers engaged in distillery factories.

**Acknowledgement :** Nil

**Conflict of Interest :** Nil

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