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A STUDY OF PULMONARY FUNCTION TEST IN SUGARCANE INDUSTRY WORKERS OF FAIZABAD DISTRICT, UTTAR PRADESH

Physiology

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ABSTRACT

Introduction: Repeated and continuous exposure to dusty working environment in sugar industry causes respiratory diseases which may adversely affect respiratory functions over a period of time. The objectives of the study were therefore to study the static and dynamic pulmonary function in individuals who are exposed to bagasse dust and to correlate the findings of PFT with various socio-demographic factors.

Material and Methods: The present cross-sectional study was conducted by the Department of Physiology, Hind Institute of Medical Sciences, Barabanki in Rauza Gaun sugar factory, Faizabad, Uttar Pradesh. Purposive sampling was applied and all 134 available workers of same factory were included in our study. About 14 participants were lost to follow up visits for PFT. So a total of 120 participants were properly studied. The pulmonary function viz. (FVC, FEV1, FEV1/FVC % etc.) was recorded by portable computerize spirometer.

Results: All workers are male by sex with age range from 18 years to 45 years of age. No significant difference between mean tidal volumes of different section of workers. IRV (Inspiratory reserve volume) was decreased for a particular section of sugarcane factory workers. There was significant difference between mean inspiratory capacities, mean vital capacity and mean partial pressure of arterial carbon dioxide concentration of different section of workers. There was no significant difference between mean partial pressure of arterial oxygen concentration of different section of workers. There was no significant difference between mean FEV1% (Forced expiratory volume) of different section. Workers conducting compressing operations showed highest decrease in RV (Respiratory volume) and DLCO.

Conclusion: The study revealed a significant association between pulmonary function abnormalities with type of work done by different section of workers in the sugar factory.

KEYWORDS:

Pulmonary function test, Bagassosis, Pulmonary impairment, Spirometry

Introduction

The precise etiologic causes of lung diseases have received more attention than those of many other illnesses, partly because the response of the lungs to external agents can be monitored (with lung function tests) with more precision than that of many other organs and partly because most lung diseases can be initiated by substances inhaled and these substances can be measured in the air we breathe.. Dust retention in the lung, and the inflammatory and fibrotic reaction to it, is often visible in chest radiographs, and pneumoconiosis were the first well-established occupational lung diseases. Control measures have led to a significant reduction in pneumoconiosis, at least in developed countries. The chest X-ray, however, can lead to much confusion in that, although the visible changes relate to cumulative exposure, they relate poorly to disability. As a "disease" was defined in terms of X-ray changes, it was assumed that persons with similar exposures and normal X-rays had no disease. Recent work, for instance, with silica and coal dust exposure, has shown that the main disability relates to airflow obstruction, which is related to cumulative exposure. The degree of impairment in the forced expiratory volume in 1 second (FEV1.0), for example, is not related to the presence or absence of X-ray changes of simple pneumoconiosis. The availability of spirometers measuring FEV1.0, and portable peak expiratory flow meters, has revolutionized the investigation of asthma and the documentation of provoking factors. Work-related decreases in peak expiratory flow can be used to document the provocation of asthma by the occupational exposure in that such changes can be seen in the absence of the traditional features of asthma, such as specific immunoglobulin E (IgE), increased nonspecific reactivity, and eosinophilia in induced sputum. Whether the workers involved have occupational asthma or another as yet unnamed airway disease, is currently unclear, as is the consequences with continued exposure. The diseases discussed so far all have features that distinguish occupational from non-occupational causes. Occupational exposures can also lead to COPD and lung cancer, both of which can be caused by occupational and non-occupational factors that produce indistinguishable disease that can only be attributed to a particular cause using epidemiologically derived estimates of risk.

Uttar Pradesh has number of sugarcane industries in different districts and Rauza Gaun Sugar factory in Faizabad district being one of the largest sugar producers, many people are engaged in this work. Inhalation of bagasse dust causes disease of respiratory system which is commonly described under the heading of hypersensitivity pneumonitis. (1) Hypersensitivity pneumonitis is a group of lung disease caused by inhalation of wide variety of materials that usually are organic and always are antigenic. (2) The concentration and pathogenicity of these bioaerosols depends on source material, method of their storage, technology of processing materials and their disposal. In India, Vishwanathan et al and Nair and Das (1970) reported reduced VC, TLC, PEFR and MVV in patient of bagassosis.(3) Since1970 no more pulmonary function studies were reported in this field in India until recently in 2008 a study was reported from western Maharashtra by Patil S N showing decrease in FVC, FEV1,PEFR and MVV in exposed group as compared to non-exposed group to Bagasse. (4) To study the pulmonary function of Bagasse worker and delineating the recent trends of diseases among workers is the need of the hour. Our present study is aimed at spirometric findings of bagasse workers. The objectives of the study were therefore to study the static and dynamic pulmonary function in individuals who are exposed to Bagasse dust and to correlate the findings of PFT with various socio-demographic factors.

MATERIAL AND METHODS

The present study was undertaken to assess the parameters of pulmonary function test of bagasse factory workers in different departments of Rauza Gaun sugar factory.

Place of Study: This study was conducted in the Department of Physiology at Hind Institute of Medical Sciences, Barabanki.

Study Area: Rauza Gaun sugar factory, Faizabad,Uttar Pradesh

Study Design : Cross-sectional descriptive study

Sampling Technique: Purposive sampling i.e. all available workers of same factory.

Study Sample: Because of study limitations we were able to include 134 participants in our study.14 participants were lost to follow up

visits for PFT. So a total of 120 participants were properly studied.

Inclusion Criteria: All the cases were of labour class. There was habit of tobacco chewing and slight intake of alcohol which does not alter or affect the pulmonary function tests. Only those workers were taken, who were exposed to dry and mouldy bagasse while: Removing bales from stacks, in compressing operations, in opening and shredding of bales, hammer milling bagasse, transporting bales to the vehicles.

Exclusion Criteria: Those having cardiovascular illness in present or past, those having respiratory symptoms in present or past in order to exclude decrease in pulmonary function test due to respiratory illnesses other than bagassosis, those having kyphoscoliosis or asthma or any allergy which influence pulmonary ventilation.

Study Participants
The pulmonary function test was done on all the workers of the Rauza Sugar Factory, Faizabad who will meet the inclusion and exclusion criteria.

Data Collection
Factory authority was informed and explained about the procedures and after getting proper assurance from authority, the study was commenced. A pre-tested interview schedule was used for data collection. A date was allotted for Pulmonary Function Test of each participant as per there convenience.

Pretesting
The schedule was pretested on a sample of 30 workers to see for the accuracy of responses and to estimate time needed. Something which was confusing or inconsistent in the pre-test exercise including the interview protocol was corrected before actual data collection. Result of pre-test was not included in final study. Completed schedules were checked weekly for consistency and completeness by the supervisors. The collected information was rechecked for its completeness and consistency before entering the data into a computer.

Data Processing and Analysis
Descriptive statistics such as frequencies, proportions for categorical variables were used to present study results. P values were calculated to test the statistical significance at the 5% level. Association between independent and dependent variables was determined using Chi Square test in univariate case. One way ANOVA was used in mean comparison to all groups.

Ethical Consideration
Verbal consent was taken from each selected participant to confirm willingness. Honest explanation of the survey purpose, description of the benefits and an offer to answer all Inquires was made to the respondents. Also affirmation that they are free to withdraw consent and to discontinue participation without any form of prejudice was made. To ensure efficiency of the survey, information was collected with the least burden to the respondent.

RESULTS:

In our study group 5 fields of sugarcane processing were chosen. It included 17.5% in removing bales from stalk, 21.7% in compressing operation, 20% in opening and shredding of bales, 22.5% in Hammer milling bagasse and 18.3% in Transporting bales to the vehicles. The study included workers of age group between 18 – 45 years. Total mean age group of study participants were 38.5±11.3. **[Table No.1]**

PULMONARY FUNCTION TEST OF STUDY PARTICIPANTS

Spirometric findings of the workers showed that there was no significant difference between mean Inspiratory reserve volume of different section of workers in ANOVA test. However mean IRV was decreased for a particular section of sugarcane factory workers i.e. workers of hammer milling bagasse. Spirometric findings of the workers showed that there was no significant difference between mean Expiratory reserve volume of different section of workers in ANOVA test. Inspiratory Capacity is sum of TV and IRV. Spirometric findings of the workers showed that there was significant difference between mean Inspiratory Capacity of different section of workers in ANOVA test. Vital Capacity is sum of TV, ERV and IRV. Spirometric findings of the workers showed that there was significant difference between mean Vital Capacity of different section of workers in ANOVA test. **[Table No.2]**

Spirometric findings of the workers showed that there was no significant difference between mean FEV1% of different section of workers in ANOVA test. Neither of the study group showed obstructive pattern of lung disease. FEV1/FVC (%) is very diagnostic of pattern of respiratory diseases i.e. obstructive pattern. However mean FEV1/FVC (%) was decreased for a particular section of sugarcane factory workers of hammer milling bagasse and highest for workers of removing bales from stalki.e.83.40±8.21% and 94.0±12.65%respectively. However inter group variation is highly significant in comparing RV which indicate towards restrictive pattern of lung disease among sugarcane workers. Low RV/TLC of lung is indicative of restrictive pattern of Lung disease. In the above study group workers conducting compressing operations showed highest decrease in RV/TLC i.e. 0.25±0.03and workers removing bales from stalk showed second lowest RV i.e. 0.26±0.15. In the above study group workers conducting compressing operations showed highest decrease in DLCO i.e. 0.25±0.03 and workers removing bales from stalk showed second lowest DLCO i.e. 0.26±0.15. However inter group variation is highly significant in comparing DLCO which indicate towards restrictive pattern of lung disease among sugarcane workers. **[Table No.3]**

Spirometric findings of the workers showed that there was no significant difference between mean partial pressure of arterial oxygen concentration of different section of workers in ANOVA test. Spirometric findings of the workers showed that there was significant difference between mean partial pressure of arterial Carbon Dioxide concentration of different section of workers in ANOVA test. **[Table No.4]**

DISCUSSION

Workers from different sections of sugarcane processing were included in the study. It included 17.5% in removing bales from stalk, 21.7% in compressing operation, 20% in Opening and shredding of bales, 22.5% in Hammer milling bagasse and 18.3% in Transporting bales to the vehicles. Tidal Volume, Expiratory Reserve Volume and Inspiratory Reserve Volume of study participants didn't show any intergroup variation in our study though IRV showed reduction in some groups i.e. workers of hammer milling bagasse. However mean ERV was decreased for a particular section of sugarcane factory workers i.e. workers of hammer milling bagasse and high for workers opening and shredding bales. Inspiratory Capacity is sum of TV and IRV. Different occupational diseases have significant association with pulmonary function impairment as shown by different studies. The study by Beuchner et al demonstrated similar findings i.e. a significant association between pulmonary function abnormalities and certain sub-occupations in the sugar factory. The majority of the workers with pulmonary impairment had ≥ 31yrs of occupational exposure. [5]the study by Patil SN et al showed that the percent of predicted values of all the parameters studied indicated that the values of all PFT parameters were significantly reduced in the direct exposure group as compared with control group, though in indirect exposure group also showed reduced values that did not a reach significant level and exposure to sugarcane dust (bagasse) and to other pollutants in a sugar factory is associated with lung dysfunction, which is more pronounced in the direct exposure group. [10] Mean FEV1% was decreased for a particular section of sugarcane factory workers opening and shredding of bales and highest for workers of compressing operations respectively. Neither of the study group showed obstructive pattern of lung disease. FEV1/FVC (%) is very diagnostic of pattern of respiratory diseases i.e. obstructive pattern. Disproportionate reduction of FEV1 to FVC (Forced Vital Capacity) is hallmark of obstructive lung disease. Workers of hammer milling bagasse showed close observations to obstructive pattern of lung disease. The spirometric PFT parameters studied by Patil SN et al showed that FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in first second), PEFR (Peak Expiratory Flow Rate), and MVV (Maximum Voluntary Ventilation) decreased. [10]A study by Beuchner et al showed that amongst the occupational exposure sub-groups, ≥ 31yrs exposed workers were maximally affected by obstructive type (21.43%), Restrictive type (14.29%) & Mixed type (3.17%) of pulmonary impairment. [5]A study by Bohadana et al in the sugar refinery showed that, workers exposed to sugar dust in the sugar cube manufacture workstation had significantly lower forced expiratory volume in 1 s (FEV1) (p = 0.02) than the non-exposed ones. [11] A study by Khan AW et al showed that male gender (p=0.002) as risk factors for impaired FEV1 improvement after exposure cessation. After adjusting for gender, smoking delayed the onset of FEV1 gain but did not affect the overall magnitude of change. Lung function improvement after cessation of exposure to organic dust is sustained.

[20] Study by Hansell et al showed that cumulative exposure to mineral dust and gases/fumes was associated with higher FEV_1% (forced expiratory volume in the first second of expiration) predicted. [22]A study by Nagoda et al in unexposed worker has a significant lower frequency ($P < 0.001$) of symptoms as well as higher ($P < 0.001$) forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR) than exposed workers. Respiratory symptoms were more prevalent among workers in most dusty sections of the factory. [23] The study by Osman E et al showed that mean FEV1 and FVC values of woodworkers, among both smokers and non-smokers, were significantly low, although the FEV1/FVC value was high ($p < 0.05$). An increase both in FEV1 and FVC values was detected among the woodworkers who had a working period less than 10 years. [27]This study conducted by Banks DE et al in 1999 relates the impact of various medical conditions to clinically important forced expiratory volume in 1 second (FEV1) declines in a cohort of steelworkers evaluated cross-sectionally and longitudinally. [30]A study by Post W et al in animal food industry showed that increasing working years was related to decreasing annual decline in FEV1 and fewer people with rapid decline in FEV1. [32]Statistically significant across-shift reductions were recorded by Zuskin et al for all ventilatory capacity tests for the group as a whole. In comparison to predicted, the measured ventilatory capacity parameters were significantly lower for all workers ($p < 0.01$). Lung function abnormalities increased with duration of employment. [33] In a study conducted by Nikhade Nitin et al showed that the highest prevalence was found in Bagasse workers (40.48%) followed by Manufacturing dept. (38.24%). Amongst the occupational exposure sub-groups, ≥ 31yrs exposed workers were maximally affected by obstructive type (21.43%), Restrictive type (14.29%) & Mixed type (3.17%) of pulmonary impairment. The study demonstrated a significant association between pulmonary function abnormalities and certain sub-occupations in the sugar factory. The majority of the workers with pulmonary impairment had ≥ 31yrs of occupational exposure. [39] Spirometric findings of the workers showed that there was no significant difference between mean partial pressure of arterial oxygen concentration of different section of workers. However mean PaO2 was decreased for a particular section of sugarcane factory workers opening and shredding of bales and highest for workers transporting bales to the vehicles respectively. In our study group workers conducting compressing operations showed highest decrease in RV and workers removing bales from stalk showed second lowest RV. Low DLCO of lung is indicative of restrictive pattern of Lung disease. Our study didn't show obstructive pattern of respiratory illness in participants and showed more towards restrictive pattern of illness. Particular segment of workers having restrictive pattern of illness must be paid attention by the factory authorities for further restriction of disease advance as this will hamper the performance, employment and productivity of workers which will indirectly hamper the productivity of factory.

CONCLUSIONS

The trend of lung disease in our study setting indicates towards restrictive pattern. Regular PFTs need to be performed to assess the disease pattern and progress. Needful measures are to be ensured by factory authorities to halt the disease progression so that there will be no loss to the factories and labourers in terms of productivity and economic status. Hypersensitive Lung diseases in sugarcane factory workers can be minimized by taking appropriate measures in handling bagasse. Labourers need to be made aware of diseases and its effect on different aspects of their health. Information, education and communication programs need to be strengthened in sugarcane factories. Cohort studies are indicated to investigate further to link between different risk factors, year of exposure and different pattern of Lung diseases.

TABLE 1: DISTRIBUTION OF WORKERS BY TYPE AND AGE

TYPE OF WORKER	NUMBER (%) N = 120	Age in years (Mean± SD)
Removing bales from stalk	21 (17.5)	31±9.9
Compressing operations	26 (21.7)	34.4±11.4
Opening and shredding of bales	24 (20.0)	29.8±21.1
Hammer milling bagasse	27 (22.5)	32.0±10.4
Transporting bales to the vehicles	22 (18.3)	33.2±9.

TABLE 2: PULMONARY FUNCTION TEST OF STUDY PARTICIPANTS

TYPE OF WORKER	TIDAL VOLUME ((TV) in liters (Mean±SD)	INSPIRATORY RESERVE VOLUME (IRV)in liters (Mean ±SD)	EXPIRATORY RESERVE VOLUME (ERV) in liters (Mean± SD)	INSPIRATORY CAPACITY (IC) in liters (Mean±SD)	Vital Capacity (VC) in liters (Mean±SD)
Removing bales from stalk	0.529±0.09	0.927±0.18	0.631±0.21	1.461±0.56	2.211±0.35
Compressing operations	0.534±0.11	0.934±0.08	0.564±0.28	1.514±0.24	2.032±0.13
Opening and shredding of bales	0.512±0.14	0.922±0.23	0.622±0.43	1.672±0.48	2.173±0.48
Hammer milling bagasse	0.513±0.19	0.883±0.19	0.483±0.17	1.273±0.47	1.943±0.07
Transporting bales to the vehicles	0.522±0.08	0.922±0.30	0.542±0.33	1.542±0.39	2.022±0.30
p value	0.62	0.91	0.39	0.02	0.01

TABLE 3: PULMONARY FUNCTION TEST OF STUDY PARTICIPANTS

TYPE OF WORKER	FEV1 (%) (Mean ±SD)	FEV1/FVC (Mean± SD)	Reserve Volume (RV) in liters (Mean± SD)	(RESE-RVE VOLUME/TOTAL LUNG CAPACITY) RV/TLC (Mean ±SD)	DIFFUS-ION CAPACITY OF LUNG FOR CARBON MONO OXIDE (DLCO) (ml/min/mm Hg) (Mean± SD)
Removing bales from stalk	86.34±11.04	94.0±12.65	1.13±0.26	0.26±0.15	101.56±11.27
Compressing operations	87.87±9.08	93.90±9.84	1.12±0.33	0.25±0.03	107.30±10.07
Opening and shredding of bales	86.73±10.66	91.90±11.44	1.22±0.56	0.31±0.17	111.51±14.20
Hammer milling bagasse	83.30±9.01	83.40±8.21	1.39±0.09	0.42±0.01	117.31±11.01
Transporting bales to the vehicles	84.37±8.22	86.77±8.64	1.41±0.06	0.28±0.11	114.66±14.87
p-value	0.43	0.001	0.00	0.00	0.00

TABLE 4: PARTIAL PRESSURE OF ARTERIAL OXYGEN AND CARBON DIOXIDE IN DIFFERENT GROUPS

TYPE OF WORKER	PaO2 in mm HG (Mean±SD)	PaCO2 in mm HG (Mean±SD)
Removing bales from stalk	95.85±5.38	34.28±3.88
Compressing operations	96.93±5.29	36.05±3.50
Opening and shredding of bales	93.88±6.44	36.33±3.57
Hammer milling bagasse	94.41±6.92	38.30±4.90
Transporting bales to the vehicles	97.33±5.66	37.08±2.85
p-value	0.195	0.01

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