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Physiology

Comparative Study of the Pulmonary Function Test of the Cotton Mattress Makers of the Age Group 30-45 Year with Normal Healthy Subject of Similar Age Group in Indore City

Dr. Ashok Kumar[1], Dr. M.P. Singh[1*], Dr. Manila Jain[2]
[1]Asst. Professor, Department of Physiology, Amaltas Institute of Medical Sciences, Dewas, Madhya Pradesh, India
[2]Professor, Index Medical College Hospital & Research Centre, Indore, Madhya Pradesh, India

Original Research Article

***Corresponding author**
Dr. M.P. Singh

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Abstract: The present study was conducted on the cotton mattress makers of Indore city of the age group of 30-45 years to assess their Pulmonary Function Tests and to compare with the normal healthy adults of the same age group. In the past, many studies have been done on the cotton industry workers and it was found that inhalation of cotton fibres result in obstructive lung disease, if exposed for a long time. Pulmonary Function Tests of study group of fifty cotton carding workers and control group of fifty healthy subjects were studied in the Department of Physiology, Index Medical College and Hospital Indore.
Keywords: Pulmonary, Cotton, Indore.

INTRODUCTION

Pulmonary Function Tests of study group of fifty cotton carding workers and control group of fifty healthy subjects were studied in the Department of Physiology, Index Medical College and Hospital Indore.

Out of fifty carding workers, the Pulmonary Function Tests of Twenty workers were repeated after the season was over to see whether there is any significant improvement in their lung functions or not.

Tidal volume of study group was (0.4620 L) less than the control group (0.5390 L) and the difference was statistically significant.

- Expiratory Reserve Volume of study group was (0.7422 L) less than the control group (1.2506 L) and statistically highly significant difference was observed.
- Inspiratory Reserve Volume of study group was 2.275 L and of control group was 2.2364 Land no significant difference was observed.
- Inspiratory Capacity of study group was 2.7330 L and of control group was 2.7744 Land no significant difference was observed.
- FEV_1/FVC % of study group was (48.02 %) less than the control group (84.92%) and statistically highly significant difference was observed.
- MEFR 25-75% of study group was (1.0734 L/sec.) less than the control group (3.8434 L/sec.) and statistically highly significant difference was observed.
- The PEFR of study group was (1.82 L/sec.) less than the control group (6.92 L/sec.) and statistically highly significant difference was observed.
- Out of 50 cases, 46 cases showed Obstructive pattern in their pulmonary function testing which
- Forced Vital Capacity (FVC) of study group was (2.91 L) less than the control group (3.97 L.) and statistically highly significant difference was observed.
- Slow Vital Capacity (SVC) of study group was (52% -103%) less than the control group (75% - 131%).
- FEV_1 of study group was (1.38 L) less than the control group (3.35 L) and statistically highly significant difference was observed.
  constitutes about 92%. This is because of cotton [1] and infectious agent causing inflammatory changes in the respiratory tract and producing narrowing of airways.
- Out of 50 cases 4 cases showed mixed pattern (i.e. both Obstructive and Restrictive) which constitutes about 8%.
- Restrictive pattern was not seen in carding workers because cotton fibres cannot penetrate the respiratory mucosa as well as alveoli
- Maximum number (62%) of cases showing Obstructive pattern had

16 -20 years of exposure to cotton dust.

- Maximum number (58%) of cases in the present study was in the age group of36 – 40 years.
- So the crux of this study is that inhalation of cotton dust, infectious agent and other material with it produces inflammation of respiratory tract causing obstruction in airways. As a result most of the expiratory parameters of lung functions decrease in carding workers.

- After the peak season of carding was over, pulmonary function tests of 20 carding workers were repeated to see any significant changes in their lung functions occurred or not and the results are as follows:-
- Tidal Volume of group S-1 was 0.49 L and group S-2 was 0.44 L and the statistically significant difference in tidal volume of both groups was not observed.
- Expiratory Reserve Volume of group S-1 was 0.741L and of group S-2 was 0.775Land the difference was statistically not significant.
- Inspiratory Reserve Volume of S-1 group was 2.23Land of group S-2 was 1.87Land the difference was statistically significant.
- Inspiratory Capacity of S-1 group was 2.72 L and of group S-2 was 2.31Land the difference was statistically significant.
- Forced Vital Capacity (FVC) of S-1 group was 2.92L and of group S-2 was 2.99Land the difference was statistically not significant.
- Forced Expiratory Volume in 1st sec. of FVC (FEV_1) of S-1 group was 1.57L and of group S-2 was 1.59L and the difference was statistically not significant.
- FEV_1/FVC of S-1 group was 53.4% and of group S-2 was 53.4% and the difference was statistically not significant.
- MEFR 25- 75% of S-1 group was 1.24L and of group S-2 was 1.12Land the difference was statistically not significant.
- The PEFR in S-1 group was 2.01L/sec and of S-2 group was 2.13L/sec and the difference were statistically not significant.

AIM & OBJECTIVES

- To assess the pulmonary functions of cotton mattress makers (carding workers) of 30-45 years of age (case).
- To assess the pulmonary function tests of healthy subject of 30-45 years not exposed to cotton dust (control).
- To compare the pulmonary functions of these workers with normal individuals of same age group (Case and Control).
- Follow up of pulmonary function tests of cotton workers (case) when exposed to lower levels of cotton dust after the season is over to see any significant changes in their lung function tests.
- To suggest the workers to take appropriate treatment whose lung functions are on progressive decline or to change the job before the disease has set in.

MATERIALS & METHODS

The present study was carried out in the Department of Physiology, Index Medical College, and Indore[2]. This is a case control study in which 50cotton mattress makers of age group 30-45 years and 50 healthy person of similar age group of Indore city were included.

Cases again divided into two groups- one comprising of 50 cases when they are exposed to more cotton [3, 4] dust in their peak season i.e. during the winter season and other comprising of follow up with repeat pulmonary [5] function tests of 20 cases when they are exposed to less cotton [6] dust after the winter season to see any changes in lung functions.

INCLUSION AND EXCLUSION CRITERIA

Case - Criteria for inclusion

- Persons of 30-45 years of age
- Cotton mattress makers exposed to cotton dust for 10 or more years.
- Individuals giving consent for tests
- Non-smokers or occasional smokers

Case - Criteria for exclusion

- Person less than 30 years of age.
- Person more than 45 years of age.
- Individuals not giving consent for tests.
- Those who are regular smokers.
- Those who are exposed to cotton dust for less than 10 years.

Control - Criteria for inclusion

- Healthy individuals of 30-45 years
- No history of chronic respiratory disease.
- Individuals giving consent for tests.
- Non-smokers or occasional smokers.
- Person not exposed to cotton dust.

Control - Criteria for Exclusion

- Persons> 30 years of age.
- Persons< 45 years of age.
- Subjects of chronic respiratory diseases.
- Individuals not giving consent for tests.
- Who regularly smoke?

The following methods were performed

- Pulmonary function tests of study group (case) and control group.
- The Pulmonary function testswere repeated in the study group in 20 cases after the carding season was over.

- Microscopic examination of cotton samples.
- Microbiological examination of cotton samples.

PROCEDURE FOR PULMONARY FUNCTION TEST

- It was ensured that the subject was not wearing items of apparel that were tight or restrictive (e.g. neck tie, buttoned shirt collar, tight belt etc.)
- Clean disposable mouthpieces with filters were replaced in measuring system for every subject.
- Test was performed on each subject in sitting position.
- Clear and simple instructions were given to the subject followed by a demonstration.
- Nose was closed during the manoeuvres.
- Mouthpiece was positioned in such a way that the subject's chin was slightly elevated and the neck was extended.
- The subject was asked to inhale and exhale normally into the mouthpiece of
  Spirometer three - four times for tidal volume
- Then subject was asked to exhale completely to his maximum effort.
- Then subject was asked to take deep inspiration from the mouthpiece.
- Then subject was asked to exhale into the mouthpiece as forcibly and completely as possible.
- Then subject was asked to take normal breathing for three to four times.
- The test was repeated three times.
- In these manoeuvres the subjects were motivated and encouraged to give their best performance.

Test was performed in the sitting position in each subject.

Body mass index was calculated as kg/m^2. Conditions where suboptimal lung function results are likely:-

- Chest or abdominal pain of any cause
- Oral or facial pain exacerbated by a mouthpiece
- Stress incontinence

Subjects should be as relaxed as possible before and during the tests.

Patients should be asked to loosen tight-fitting clothing.

Ambient temperature, barometric pressure and time of day must be recorded.

The goal of infection control is to prevent the transmission of infection to case and control and staff during pulmonary function testing.

Activities that should preferably be avoided prior to lung function testing:

- Wearing clothing that substantially restricts full chest and abdominal expansion.
- Eating a large meal within 2 hr of testing.

Assessment of Pulmonary Function Test Parameters

The following parameters were assessed by Ganshorn Computerized Spirometer

- TV : Tidal Volume
- ERV: Expiratory Reserve Volume
- IRV : Inspiratory Reserve Volume
- IC : Inspiratory Capacity
- FVC : Forced Vital Capacity
- FEV_1: Forced Expiratory Volume in 1^{st} second of FVC
- FEV_1/FVC : Ratio of FEV_1 and FVC
- MEF25-75%: Maximum Forced Expiratory Flow during the Middle half of FVC.
- PEFR : Peak Expiratory Flow Rate

Examination of Cotton Sample

Examination of cotton sample before and after carding: - The workers engaged in the processing and spinning of cotton are exposed to significant amounts of cotton dust. They are also exposed to particles of pesticides and soil. Exposure to cotton dust and other particles leads to respiratory disorders among the cotton workers.

Several studies demonstrated that different components of cotton dust can recruit neutrophils into bronchi. Component of cotton dust also stimulate resident pulmonary cells such as mast cells and macrophages to release substances that attract neutrophils [1].

There is now a large amount of information pointing Lipopolysaccharide (Endotoxin)[2] produced by bacterial contamination of cotton as a causative agent of Byssinosis [3] in cotton workers as these workers refill and quilt old mattresses which are infected and contaminated with bacteria.

Keeping this thing in mind, two cotton samples were collected from the place of carding first is before carding and second is after carding.

STATISTICAL ANALYSIS

Data thus obtained were analyzed by t-test with the help of SPSS software for statistical analysis.

The Mean

To obtain the mean the individual observations were first added together and then divided by the number of observations. The operation of adding together is called summation and is denoted by sign $\sum$. The individual observation is denoted by the sign η and the mean is denoted by the sign called "x bar"

The Standard Deviation: - It is the most frequently used measure of deviation. It is defined as "Root-Mean-Square-Deviation". It is denoted by the Greek letter σ (sigma) or by the initials S.D. The Standard Deviation is calculated by the formula

RESULTS

Table-01: Percentage of subjects according to various pulmonary function test patterns

S.No.	Disease pattern	No. of cases	Percentage %
1.	Obstructive	46	92
2.	Mixed (Obstructive & Restrictive)	04	8
3.	Restrictive	00	00
Total		50	100

The above table shows that 92% of cases (n=46) showed obstructive pattern and 8% cases (n=4) showed mixed (both obstructive and restrictive) pattern while none of the cases showed restrictive pattern on lung function testing. So the inference of the present study is that cotton carding workers have *Obstructive Airway Disease* following inhalation of cotton dust for at least 10 years of exposure.

Table-02: Comparison of Age (in years) between group S-1 and S-2

Group	Sample Size (N)	Mean Age (in years)	Standard Deviation (SD)	t-value	p-value
S-1	20	38.25	3.259	-0.620	0.539
S-2	20	38.90	3.370		

The above table shows

Group S-1 is having the mean age of 38.25±3.259 years.

Group S-2 is having the mean age of38.90±3.370 years.

Statistically no significant difference was observed in age of group S-1 and S-2.

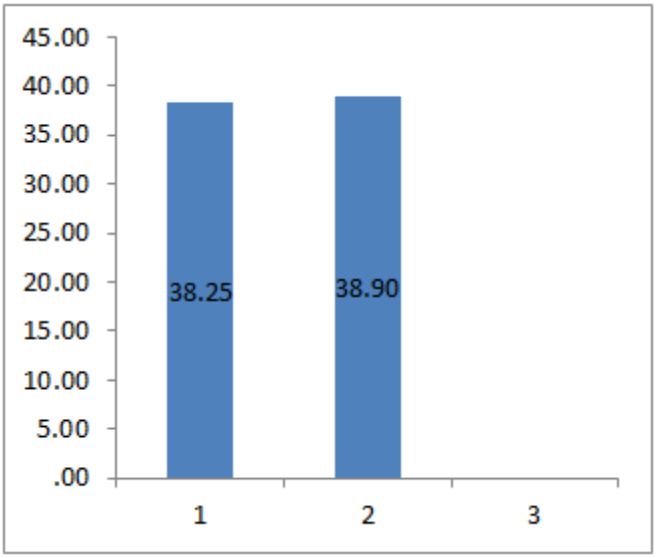

Fig-02: Comparison of Age (in years) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-03: Comparison of BMI (Kg/m^2) between group S-1 and S-2

(BMI: Body Mass Index in (Kg/ m^2)

Group	Sample Size (N)	Mean BMI (Kg/m^2)	Standard Deviation (SD)
S-1	20	20.89	0.99
S-2	20	20.87	1.13

The above table shows

Group S-1 is having the mean BMI of 20.89 ± 0.99 (Kg/m^2).

Group S-2 is having the mean BMI of 20.87 ± 1.13 (Kg/m^2).

According to WHO the normal range of BMI is from 18.5 – 24.9 (Kg/ m^2)

So, the mean BMI of both the groups is within normal range.

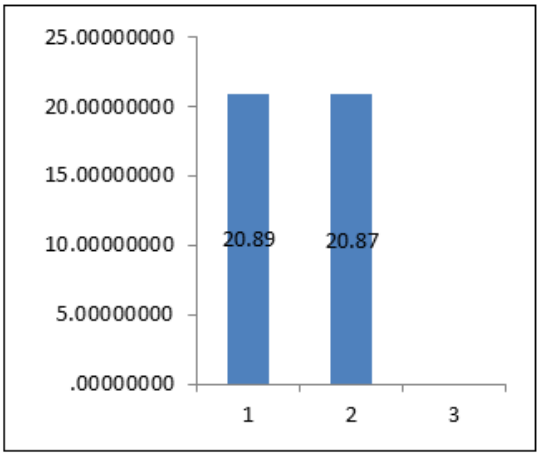

Fig-03: Comparison of BMI (Kg/m^2) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-04: Comparison of T.V. (in Litres) between group S-1 and S-2

(T.V.: Tidal Volume)

Group	Sample Size (N)	Mean T.V. (in Litres)	Standard Deviation (SD)	t-value	p-value
S-1	20	0.49	0.21	0.974	0.339
S-2	20	0.44	0.09		

The above table shows

Group S-1 is having the mean Tidal Volume of 0.49±0.21 litres.

Group S-2 is having the mean Tidal Volume of 0.44±0.09 litres.

Statistically no significant difference was observed in tidal Volume of group S-1 and S-2.

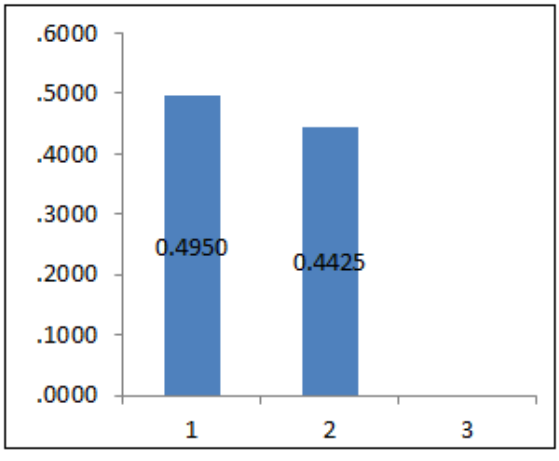

Fig-04: Comparison of T.V. (in Litres) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-05: Comparison of ERV (in Litres) between group S-1 and S-2 (ERV: Expiratory Reserve Volume)

Group	Sample Size (N)	Mean ERV (in Litres)	Standard Deviation (SD)	t-value	p-value
S-1	20	0.741	0.353	-0.401	0.692
S-2	20	0.775	0.136		

The above table shows

Group S-1 is having the mean Expiratory Reserve Volume of0.741±0.353 litres.

Group S-2 is having the mean Expiratory Reserve Volume of 0.775 ± 0.136 litres.

Statistically no significant difference was observed in Expiratory Reserve Volume of group S-1 and S-2.

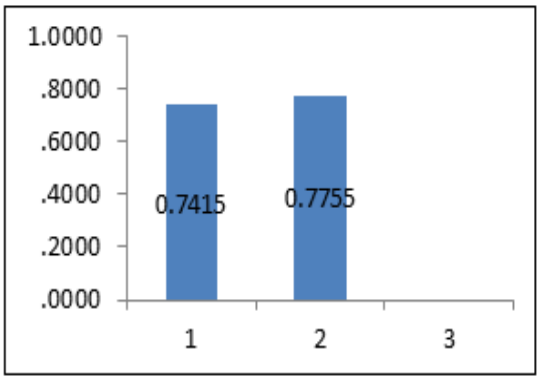

Fig-05: Comparison of ERV (in Litres) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-06: Comparison of IRV (in Litres) between group S-1 and S-2

(IRV: Inspiratory Reserve Volume)

Group	**Sample Size (N)**	**Mean IRV (in Litres)**	**Standard Deviation (SD)**	**t-value**	**p-value**
S-1	20	2.23	0.304	4.28	0.00
S-2	20	1.87	0.234		

The above table shows

Group S-1 is having the mean Inspiratory Reserve Volume of 2.23±0.304 litres.

Group S-2 is having the mean Inspiratory Reserve Volume of1.87±0.234 litres.

Statistically significant difference was observed in Inspiratory Reserve Volume of group S-1 and S-2.

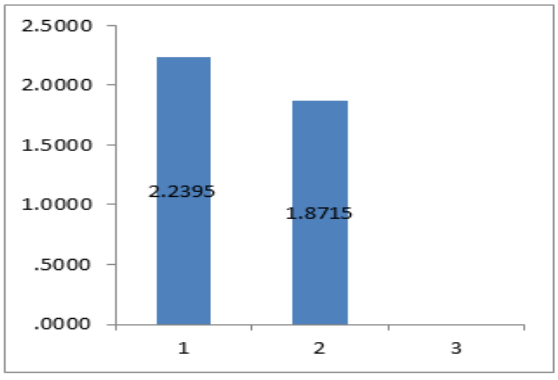

Fig-06: Comparison of IRV (in Litres) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-07: Comparison of IC (in Litres) between group S-1 and S-2

(IC: Inspiratory Capacity)

Group	Sample Size (N)	Mean IC (in Litres)	Standard Deviation (SD)	t-value	p-value
S-1	20	2.72	0.46	3.41	0.002
S-2	20	2.31	0.28		

The above table shows

Group S-1 is having the mean Inspiratory Capacity of2.72± 0.46 litres.

Group S-2 is having the mean Inspiratory Capacity of 2.31 ± 0.28 litres.

Statistically significant difference was observed in Inspiratory Capacity of group S-1 and S-2.

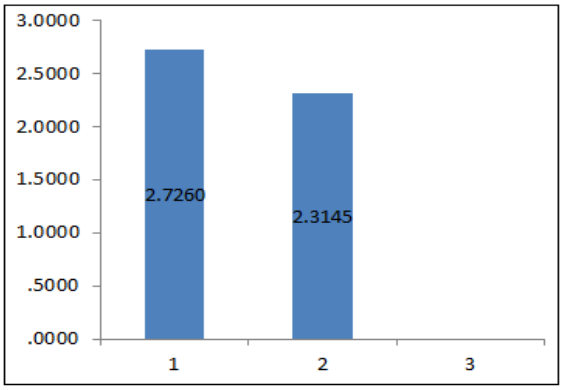

Fig-07: Comparison of IC (in Litres) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-08: Comparison of FVC (in Litres) between group S-1 and S-2 (FVC: Force Vital Capacity)

Group	**Sample Size (N)**	**Mean FVC (in Litres)**	**Standard Deviation (SD)**	**t-value**	**p-value**
S-1	20	2.92	0.456	- 0.489	0.628
S-2	20	2.99	0.366		

The above table shows

Group S-1 is having the mean Force Vital Capacityof2.92±0.456 litres.

Group S-2 is having the mean Force Vital Capacity of 2.99± 0.366 litres.

Statistically no significant difference was observed in Force Vital Capacity of group S-1 and S-2.

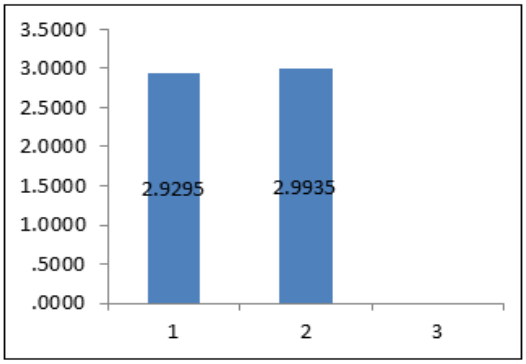

Fig-8: Comparison of FVC (in Litres) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-09: Comparison of FEV-1 (in Litres) between group S-1 and S-2 (FEV_1: Force Expiratory Volume in 1st second of FVC)

Group	Sample Size (N)	Mean FEV_1 (in Litres)	Standard Deviation (SD)	t-value	p-value
S-1	20	1.57	0.352	- 0.221	0.826
S-2	20	1.59	0.390		

The above table shows

Group S-1 is having the mean FEV-1 of 1.57± 0.352 litres.

Group S-2 is having the mean FEV-1 of 1.59± 0.39 litres.

Statistically no significant difference was observed in $FEV_1$of group S-1 and S-2.

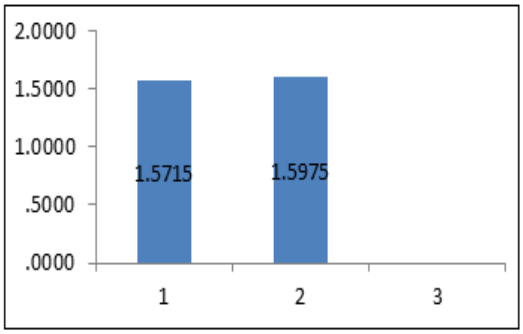

Fig-9: Comparison of FEV_1 (in Litres) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-10: *Comparison of* FEV_1/FVC (in %) *between group S-1 and S-2*

Group	Sample Size (N)	Mean FEV_1/FVC %	Standard Deviation (SD)	t-value	p-value
S-1	20	53.4	10.68	0.00	1.00
S-2	20	53.4	10.92		

The above table shows

Group S-1 is having the mean FEV_1/FVC % of53.4 ± 10.68 %.

Group S-2 is having the mean FEV_1/FVC % of53.4 ± 10.92 %.

Statistically no significant difference was observed in FEV_1/FVC %of group S-1 and S-2.

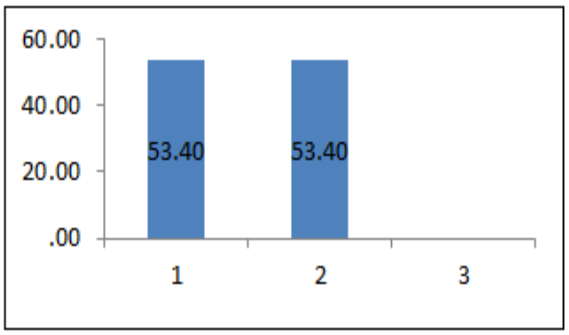

Fig-10: Comparison of FEV_1/FVC (in %) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-11: Comparison of MEFR 25 –75 % (in L/sec.) between group S-1 and S-2

(MEFR 25-75%: Maximum Expiratory Flow Rate between 25-75% of FVC)

Group	Sample Size (N)	Mean MEFR 25 –75 % (L/sec.)	Standard Deviation (SD)	t-value	p-value
S-1	20	1.24	0.43	0.906	0.371
S-2	20	1.12	0.46		

The above table shows:-

Group S-1 is having the mean MEFR 25-75% of1.24±0.43 L/Sec.

Group S-2 is having the mean MEFR 25-75% of 1.12±0.46 L/Sec.

Statistically no significant difference was observed in MEFR 25-75% of group S-1 and S-2.

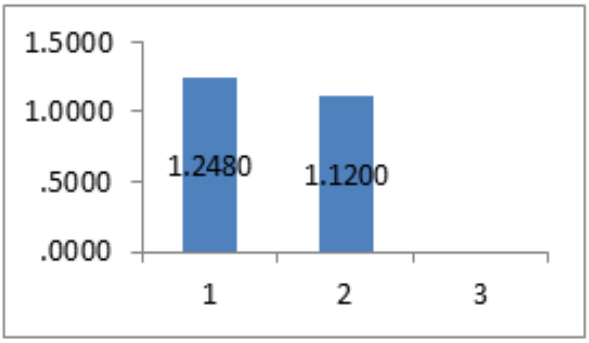

Fig-11: Comparison of MEFR 25 –75 % (in L/sec.) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Table-12: Comparison of PEFR (L / Sec.) between group S-1 and S-2

(PEFR: Peak Expiratory Flow Rate)

Group	Sample Size (N)	Mean PEFR (L / Sec.)	Standard Deviation (SD)	t-value	p-value
S-1	20	2.01	0.549	-	0.524
S-2	20	2.13	0.631	0.643	

The above table shows:-

Group S-1 is having the mean PEFR of2.01±0.549 L/Sec.

Group S-2 is having the mean PEFR of 2.13±0.631 L/Sec.

Statistically no significant difference was observed in PEFR of group S-1 and S-2.

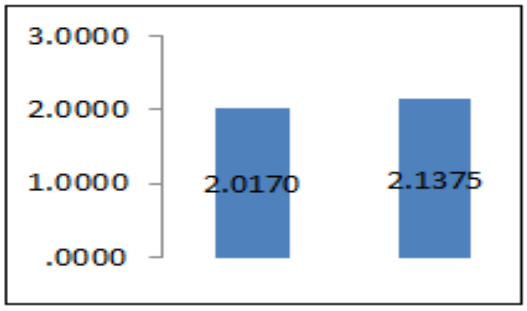

Fig-12: Comparison of PEFR (L / Sec.) between group S-1 and S-2

1 = Group S-1

2 = Group S-2

Sample size- 20 each

Distribution of cases according to duration of exposure (in years) to cotton dust:
Group A: - Duration of exposure is 10-15 years.
Group B: - Duration ofexposure is 21-25 years.

CONCLUSION

In the view of the above observations and discussion it is concluded that

- The inhalation of the cotton dust in carding workers is responsible for affecting the pulmonary functions which can be obstructive and mixed type (Obstructive and Restrictive both).
- More is the duration of exposure to cotton dust; more will be decline in the pulmonary functions.
- The cause of Cotton Workers' Disease can be cotton fibres, dust, bacterial endotoxin and histamine producing antigenic or non-antigenic substances present in the cotton dust.
- The process of carding only causes straightening of the cotton fibres and removal of the dust, but the bacteria and other substances persist in the cotton even after the carding.
- We can prevent the occupational hazard in carding workers by educating them regarding environment and nutrition, improving the sanitation and working climatic conditions.
- The cotton pillows and mattresses used by the patients suffering from chronic infectious diseases should be used carefully, as the infected material falling on the pillows and mattresses can be responsible for spreading infection to other persons.
- If the carding worker is showing continuous deterioration of pulmonary function test, he should be advised to discontinue the work till the pulmonary function tests start reverting back.

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