A Cross-Sectional Study of Pulmonary Function Tests in Grain Workers in Wardha District

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Citation

Abstract
Agriculture is one of the most hazardous occupations. The Cross-Sectional study was conducted to determine the Pulmonary function parameters of the study subjects and to co-relate the Pulmonary function parameters with their occupation. Pulmonary Functions (FVC, FEV\textsubscript{1} & FEV\textsubscript{1}/FVC ratio) was tested with computerized RMS Medspiror in sitting position of 100 grain workers and 100 sedentary workers. The sedentary people were having higher mean of observed FVC, FEV\textsubscript{1}, FEV\textsubscript{1}% of 86.98%, 84.85% & 98.76% as compared to grain workers with 79.52%, 77.59% & 91.82% respectively. By Least Significant Difference (LSD) Post Hoc Range test, it was seen that there was significant difference among the mean of the predicted value of FVC, FEV\textsubscript{1} & FEV\textsubscript{1}% of Grain workers with sedentary. Paucity of data concerning health and safety of agricultural workers provides strong rationale for rural health professionals to initiate research and educational programs focusing on health promotion/safety needs of agricultural workers.

INTRODUCTION
At the beginning of the 20\textsuperscript{th} century, grain workers were believed to be healthier than the general population. Exposure to fresh countryside air and physical work were thought to be the source of this improved health. Agriculture is so intimately tied to the land, that it had generated many myths about the health of grain workers (1,2). The long-standing “agrarian myth” was exemplified in Thomas Jefferson’s declaration that “Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bonds” (3).

Unfortunately, the myth of the robust, reliably healthy grain worker was in actuality a myth that does not correspond with the realities of agricultural life (4).

Agriculture is considered one of the most hazardous occupations. Grain workers not only had significantly higher rates of mortality from occupational injuries, but they also had higher rates of many chronic diseases such as cardiovascular and chronic obstructive pulmonary disease (1). Respiratory diseases associated with agriculture were one of the first-recognized occupational hazards. As early as 1555, Olaus Magnus warned about the dangers of inhaling grain dusts, and the risk was again noted in 1700 by Ramazzini in his seminal work De Morbis Artificum (5).

Yet, despite this early recognition of respiratory hazards in agriculture, it has only been in the 20\textsuperscript{th} century that this problem has been carefully studied and documented. In general, the investigation of agricultural respiratory hazards has lagged behind the investigation of hazards in mining and other heavy industries. These agricultural hazards, however, are of serious concern. (6)

The range of lung diseases resulting from agricultural work is not surprising when one looks at the breadth and high concentration of toxic exposures on the farm. Pulmonary toxins include organic dusts (animal, vegetable products, pollens), infectious agents (bacteria, fungi, viruses, mycobacterium), endotoxins and glucans, toxic chemicals (solvents, fuels, disinfectants), pesticides (paraquat, fungicides, organophosphates), gases from silos, welding and animal waste (NH\textsubscript{3}, Cl\textsubscript{2}, H\textsubscript{2}S, CO\textsubscript{2}, CO, NO, NO\textsubscript{2} etc), inorganic dusts (silica, silicates, clays), fertilizers, and feed additives (7).

The impact on the respiratory system may also vary considerably. Indeed, the spectrum of respiratory diseases from agricultural exposures reads like a textbook of occupational lung disease. Organic exposures may affect the airways and, depending on the antigenicity of the material...
and host susceptibility, may result in asthma, asthma-like syndrome, or chronic obstructive airway disease (6). The changing patterns of agriculture have paradoxically contributed to both improved working conditions and increased exposure to respiratory hazards (4).

Ample data, described in part in these pages, confirm the magnitude and severity of respiratory diseases in agriculture. Numerous studies, many cited in this work have demonstrated a significantly increased risk of respiratory morbidity among grain workers. This risk obtains despite the lower prevalence of smoking among them; compared with the general population, thus further implicating occupational risk factors for respiratory disease (4).

The purpose of this work is to study respiratory conditions as they relate to these work environments. In discussing and categorizing these disease entities, this study has been limited by the current knowledge and understanding of a too-little-understood area. It is beyond the scope of this study to include all-agricultural related diseases. Consideration was therefore limited to conditions for which respiratory effects are an important part of the clinical syndrome. Paucity of data in a rural set-up relating to grain workers in comparison to sedentary subjects has prompted us to take up this study. This study was conducted to determine the effect of occupation on Pulmonary function tests in grain workers and sedentary people.

**MATERIALS AND METHODS**

**SETTING**

Research laboratory, Dept of Physiology, Jawaharlal Nehru Medical College, Sawangi (M), Wardha.

**DESIGN**

The present study is a Cross-Sectional Study.

**DETAIL RESEARCH PLAN**

Institutional Ethical Committee Clearance was obtained for the study. The 100 subjects were enrolled in the study comprising of 50 each of grain workers, and sedentary people. Both males and females were included in the study.

**INCLUSION CRITERIA:**

- Age between 20 to 70 years
- In present occupation for at least 2 years
- Subjects who were willing to participate and gave informed consent.

**EXCLUSION CRITERIA:**

- Age less than 20 years and more than 70 years.
- In present occupation for less than 2 years.
- Subjects not willing to participate.
- Subjects with infectious diseases like tuberculosis, pneumonia etc

**RESEARCH METHODOLOGY**

The selected subjects were explained about the purpose of the study. They were also assured that the information and results of the tests shared will be confidential and will not be passed to any agency or to their employer. Participants could discontinue the study at any point, or chose not to answer specific question or examination. The history and examination was developed keeping in mind the objectives of the study.

The data was collected using preformed Proforma by history taking and physical examination. Around 5-6 subjects were examined per week in the Human Physiology Laboratory of the Dept. of Physiology. They were asked to attend the Dept. in the morning hours. On their arrival in the Laboratory, a detailed history and clinical evaluation was done.

Their Pulmonary Functions like FVC, FEV₁ and FEV₁/FVC ratio was tested with computerized RMS Medspiror (PC Based, Windows Version, RMS Recorders and Medicare Systems) in sitting position.

The patients were not allowed to eat a heavy meal before the test; neither smoke nor take hot drinks for four to six hours beforehand. So also if the subjects were on some bronchodilator therapy, they were told to discontinue it for 48 hours.

The subjects were given proper instructions prior to the procedure. The subjects were asked to place a mouthpiece attached to the spirometer in their mouth. The patient places a clip over the nose and breathes through the mouth into a tube connected to a spirometer After breathing normally subjects were asked to slowly blow out until their lungs are empty. Then they were instructed to take a deep breath, filling up lungs completely. As soon as the lungs were full, they were told to blow out as hard and as fast as they could until they felt that their lungs were are absolutely empty. Then immediately they were asked to inhale as deep and as fast as possible. They were asked to repeat the test until there...
were three good efforts. The test was terminated if the patient showed signs of significant head, chest, or abdominal pain while the procedure was in progress.

The following parameters of the PFT were included in the study:

- Forced Vital Capacity (FVC)
- Forced Expiratory Volume in the first second (FEV1)
- FEV1 %

**STATISTICAL ANALYSIS**

All the data of each subjects were noted down for further analysis. The data analysis was done using appropriate statistical test by SPSS statistical package like percentage and ANOVA- Least Significant Difference (LSD)-Post Hoc Range test.

**RESULTS**

**Figure 1**

Table 1: Age-wise distribution of subjects among different study groups

<table>
<thead>
<tr>
<th>Study Groups</th>
<th>Age Groups</th>
<th>Mean Age in Years (±SD Error Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain workers</td>
<td>&lt;30 yrs</td>
<td>26.81 ± 0.36</td>
</tr>
<tr>
<td></td>
<td>30-60 yrs</td>
<td>46.33 ± 2.19</td>
</tr>
<tr>
<td></td>
<td>&gt;60 yrs</td>
<td>65.85 ± 1.30</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>45.56 ± 2.35</td>
</tr>
<tr>
<td>Sedentary</td>
<td>&lt;30 yrs</td>
<td>25.67 ± 0.23</td>
</tr>
<tr>
<td></td>
<td>30-60 yrs</td>
<td>46.08 ± 1.16</td>
</tr>
<tr>
<td></td>
<td>&gt;60 yrs</td>
<td>64.54 ± 0.83</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>41.82 ± 1.96</td>
</tr>
</tbody>
</table>

The mean age of all the 100 subjects in the study was 41.36 ± 1.25 years. The mean age of grain workers was 45.56 ± 2.35 years and that of the Sedentary people was 41.82 ± 1.96 years. The total study comprised of 100 subjects. 50 each of Grain workers and Sedentary group. Out of 50 grain workers 19 (38%) were females and 31 (62%) were males. In sedentary group, males & females were 25 (50%) each. Total elderly (more than 60 years) grain workers were 14 (28.0%) while sedentary workers were 6(12%). 32% of the grain workers and sedentary people were in this age group (Not in the table).

**Figure 2**

Table 2: Showing PFT parameters (Mean ± S E) in different study groups

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Study Group</th>
<th>FVC (% of pred) Mean ± SE</th>
<th>FEV1 (% of pred) Mean ± SE</th>
<th>FEV1 % (% of pred) Mean ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grain workers</td>
<td>79.5 ± 1.6</td>
<td>77.5 ± 2.3</td>
<td>91.8 ± 1.8</td>
</tr>
<tr>
<td>2</td>
<td>Sedentary</td>
<td>86.9 ± 1.1</td>
<td>84.5 ± 1.2</td>
<td>98.7 ± 1.8</td>
</tr>
</tbody>
</table>

The sedentary people were having higher mean of observed FVC of 86.98% as compared to grain workers with 79.52%. So also the sedentary were having higher mean of FEV1 of 84.85% as compared to grain workers with 77.59%. Similarly the sedentary were having higher mean of FEV1% of 98.76% as compared to grain workers with 91.82%.

**Figure 3**

Table 3: Multiple Comparison of occupation by ANOVA (LSD) in relation to PFT parameters

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>PFT</th>
<th>Study Group</th>
<th>Mean Difference</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FVC</td>
<td>Grain workers Vs Sedentary</td>
<td>-7.1*</td>
<td>0.003 (3)</td>
</tr>
<tr>
<td>2</td>
<td>FEV1</td>
<td>Grain workers Vs Sedentary</td>
<td>-7.2*</td>
<td>0.03 (5)</td>
</tr>
<tr>
<td>3</td>
<td>FEV1%</td>
<td>Grain workers Vs Sedentary</td>
<td>-6.9*</td>
<td>0.012 (8)</td>
</tr>
</tbody>
</table>

By Least Significant Difference (LSD) Post Hoc Range test, it was seen that there was significant difference among the mean of the predicted value of FVC, FEV1, FEV1 % of Grain workers with sedentary.

**Figure 4**

Table 4: FVC status with duration of work in different study groups

As the duration of Occupational exposure increased the percentage of abnormal subjects also increased particularly more in Grain workers while this was not seen in the sedentary subjects.
6% of the grain workers with less than 5 years of exposure were abnormal which increased to 22% after 10 years of exposure. No such increase was seen in the sedentary subjects.

**Figure 5**
Table 5: FEV1 status with duration of work in different study groups

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Years in Occupation</th>
<th>Normal (≥80%)</th>
<th>Abnormal (&lt;80%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain workers</td>
<td>&lt;5 yrs</td>
<td>12 (25%)</td>
<td>6 (12%)</td>
<td>18 (18%)</td>
</tr>
<tr>
<td></td>
<td>6-10 yrs</td>
<td>14 (24%)</td>
<td>10 (18%)</td>
<td>24 (24%)</td>
</tr>
<tr>
<td></td>
<td>&gt;10 yrs</td>
<td>16 (30%)</td>
<td>14 (26%)</td>
<td>30 (30%)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>&lt;5 yrs</td>
<td>5 (12%)</td>
<td>5 (12%)</td>
<td>10 (100%)</td>
</tr>
<tr>
<td></td>
<td>6-10 yrs</td>
<td>12 (24%)</td>
<td>7 (14%)</td>
<td>19 (100%)</td>
</tr>
<tr>
<td></td>
<td>&gt;10 yrs</td>
<td>15 (30%)</td>
<td>5 (10%)</td>
<td>20 (100%)</td>
</tr>
</tbody>
</table>

The percentage of abnormal subjects increased with the duration of years in occupation. This was particularly marked in grain workers while this was not seen in the sedentary subjects.

12% of the grain workers with less than 5 years of exposure were abnormal which increase to 30% after 10 years of exposure. No such increase was seen in the sedentary subjects were even after 10 years the % abnormality was 10% which was same as in 5 years.

**Figure 6**
Table 6: Status of FEV1% with duration of work in different study groups

Grain workers had total abnormal FEV1% values of 16% while it was just 8% in sedentary subjects.

12.5% of the grain workers with less than 5 years of exposure were abnormal which increased to 62.5% after 10 years of exposure. But the increase seen in the sedentary subjects was only from 25% (<5 years of exposure) to 50% (>10 years of exposure).

**Figure 7**
Table 7: Age-wise FVC status among different study groups

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Age Group</th>
<th>Normal (≥80%)</th>
<th>Abnormal (&lt;80%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain workers</td>
<td>&lt;30 yrs</td>
<td>12 (75%)</td>
<td>4 (25%)</td>
<td>16 (100%)</td>
</tr>
<tr>
<td></td>
<td>30-60 yrs</td>
<td>10 (62.5%)</td>
<td>6 (37.5%)</td>
<td>16 (100%)</td>
</tr>
<tr>
<td></td>
<td>&gt;60 yrs</td>
<td>7 (50%)</td>
<td>7 (50%)</td>
<td>14 (100%)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>&lt;30 yrs</td>
<td>10 (83.3%)</td>
<td>2 (16.7%)</td>
<td>12 (100%)</td>
</tr>
<tr>
<td></td>
<td>30-60 yrs</td>
<td>8 (66.7%)</td>
<td>4 (33.3%)</td>
<td>12 (100%)</td>
</tr>
<tr>
<td></td>
<td>&gt;60 yrs</td>
<td>5 (41.6%)</td>
<td>7 (58.4%)</td>
<td>12 (100%)</td>
</tr>
</tbody>
</table>

This table shows a gradual decline in FVC with advancement of age in grain workers. 25% of grain workers under 30 years were abnormal but over 60 years of age 50% of them were abnormal. This trend was not observed in sedentary subjects in which the abnormality in FVC was almost similar under the age of 30 years and above 60 years (12.5% and 16.7% respectively).

**Figure 8**
Table 8: Age-wise FEV1 values among different study groups

Grain workers had total abnormal FEV1 values of 16% while it was just 8% in sedentary subjects.

12.5% of the grain workers with less than 5 years of exposure were abnormal which increased to 62.5% after 10 years of exposure. So also 18.8%, 14.3% and 33.3% had low FEV1 value in sedentary subjects under 30 years, 30 to 60 years and over 60 years of exposure.
However as it was obvious the decline in FEV1 in sedentary subjects was not as much as compared to the other two groups.

**Figure 9**
Table 9: Age-wise status of FEV1% among different study groups

<table>
<thead>
<tr>
<th>Study Group</th>
<th>Age Group</th>
<th>Normal (≥80%)</th>
<th>Abnormal (&lt;80%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain workers</td>
<td>&lt;30 yrs</td>
<td>14 (87.5%)</td>
<td>2 (12.5%)</td>
<td>16 (100%)</td>
</tr>
<tr>
<td>Grain workers</td>
<td>30-40 yrs</td>
<td>17 (83%)</td>
<td>3 (17%)</td>
<td>20 (100%)</td>
</tr>
<tr>
<td>Grain workers</td>
<td>&gt;60 yrs</td>
<td>11 (78.5%)</td>
<td>3 (21.5%)</td>
<td>14 (100%)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>&lt;30 yrs</td>
<td>14 (87.5%)</td>
<td>2 (12.5%)</td>
<td>16 (100%)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>30-40 yrs</td>
<td>26 (92.9%)</td>
<td>2 (7.1%)</td>
<td>28 (100%)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>&gt;60 yrs</td>
<td>5 (83.3%)</td>
<td>1 (16.7%)</td>
<td>6 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>45 (90%)</td>
<td>5 (10%)</td>
<td></td>
</tr>
</tbody>
</table>

This table shows that 87.5% of the grain workers under 30 years were normal while 78.6% were normal over 60 years. The percentage of sedentary subjects with normal FEV1% under 30 years was 87.5% while above 60 years it was 83.3%. So fewer declines in FEV1 % was seen in sedentary as compared to grain workers.

**DISCUSSION**

In our study the mean age of grain workers and the sedentary subjects were 45.56 ± 2.35 years and 41.82 ± 1.25 years respectively (Table 1).

Similar studies conducted in other countries showed that unlike many other occupations, grain workers often continue to work well beyond 65 years of age. Eighteen percent of U.S. farm operators are over the age of 65 years (10).

So also, the study of Kennedy et al (48) showed that Grain retirees were slightly older than civic retirees (69 versus 67 yr, p < 0.05).

More than 3.1 million workers were employed in the agriculture, forestry, and fishing industry during 2001. Compared with all industries, agriculture employed proportionately more workers aged 55 and older (22.9% versus 13.6% for all industries) (11).

Pulmonary Function Profile was analyzed and compared between the study groups. In our study the sedentary people were having higher mean of predicted value FVC of 86.98 ± 1.10 %, FEV1 of 84.85 ± 1.65 %, FEV1% of 98.76 ± 1.89 % as compared to grain workers.

Similar findings were also noted in the study conducted by SM Kennedy (48), in which he had reported lower levels of FEV1 and FVC in grain workers as compared to sedentary with FEV1-78.6 versus 88.2% pred and FVC-90.0 versus 97.7% pred (both p < 0.05) than people with other occupations, which was similar to our study in which the difference of predicted value of FEV1 and FVC between grain workers and sedentary subjects was found to be statistically significant (p < .05).

So also a 5-year prospective study conducted by Donham K J found that nearly 20% of farm workers had respiratory diseases, which were significantly more prevalent, compared to sedentary comparison group (12).

The obtained results indicate that grain workers exposed to large concentrations of grain dust and associated microorganisms during harvesting and threshing may be under the increased risk of work- related pulmonary disorders. Several studies have indicated that long-term exposure may lead to chronic respiratory disease (13,14) and excessive loss of lung function (15,16), whereas others have not (17).

There are specific respiratory hazards associated with the various commodities and associated work practices. Respiratory disease is one of the main chronic conditions among grain workers (18). More than 250 agents have been adequately documented as causing immunologic occupational asthma (19).

Allergens: Allergens encountered include allergic protein components in grain dusts and animal danders in confinement facilities. Biologic mechanisms involved in the inflammatory response include complement activation, neutrophil chemotactic activity, and increased peripheral blood neutrophil response (20,21).

Whether immunologic occupational asthma is induced by sensitizers, T cells appear to play an important role in the orchestration of the inflammatory process, and eosinophils, mast cells, epithelial cells, and neutrophils are the main effector cells that produce the characteristic features of asthma (i.e., smooth muscle contraction, mucus hypersecretion, airway inflammation, and epithelial injury). It has been hypothesized that allergic asthma is driven and
maintained by the persistence of a specialized subset of chronically activated T memory cells sensitized against aeroallergenic, occupational, or viral antigens.

Nonimmunologic or Irritant-Induced Occupational Asthma: It has been hypothesized that irritant-induced epithelial damage is followed by direct activation of nonadrenergic, noncholinergic pathways via axon reflexes and onset of neurogenic inflammation (24). Nonspecific macrophage activation and mast cell degranulation may also occur. Recruitment of other inflammatory cells likely enhances the inflammatory response. The damaged bronchial epithelium may contribute to the persistence of the inflammatory response by release of proinflammatory mediators but also may exhibit impaired function (e.g., reduced neutral endopeptidase activity, decreased generation of epithelial-derived relaxing factor). Irritant-induced airway inflammation may alter epithelial permeability such that subepithelial irritant receptors are more likely to be exposed to nonspecific stimuli such as cold air, exercise, cigarette smoke, and other inhaled irritants. Stimulation of these receptors may further increase the likelihood of persistence of airway inflammation and nonspecific airway hyperresponsiveness.

Dusts (Organic and Inorganic): Very high concentrations of inorganic dusts the bulk of which is silicates, are generated by field activities such as plowing, tilling, haying, and harvesting. Silica is known to cause pneumoconioses consisting of restrictive lung disease. Inorganic dusts, however, do not contribute to agricultural respiratory disease to the same extent as organic dusts (25).

Under certain conditions organic dusts contain biologically active proteins that may be allergenic and proinflammatory. The biologically active compounds contained in dust, along with coexisting toxicant gases, raise concerns regarding possible additive or synergistic toxic exposures and respiratory health (26).

Endotoxins and Inflammation: Intertwined with these allergenic exposure-related effects is the role of bacterial endotoxins generated in these same environments. These heat-stable lipopolysaccharides (LPSs) contain a biologically active lipid (lipid A) presumed to be responsible for the adverse health effects of endotoxins (27).

It has long been acknowledged that certain occupational exposures will exacerbate or even cause cardio-respiratory disease. Some of these exposures are very common in the workplace; others are now quite rare.

There is a large amount of epidemiological data pointing to an association between occupational exposure and the prevalence of respiratory diseases. However, as these disorders are often based on a variety of non-occupational factors such as exposure to tobacco smoke, a distinct separation into either occupational or personally associated can be difficult.

The specific role played by physical activity, job related factors (industrial noise, pollution and so on) and environmental factors on respiratory status needs to be clearly defined. The changing patterns of agriculture have paradoxically contributed to both improved working conditions and increased exposure to respiratory hazards.

It is clear that present-day exposures to dusts and gases in farms are associated with acute and chronic respiratory diseases. Agriculture includes multiple occupational and environmental exposures with widely varying work practices. There are specific respiratory hazards associated with the various commodities and associated work practices. Many studies indicate that respiratory disease is one of the main chronic conditions among grain workers. More than 250 agents have been adequately documented as causing occupational asthma (28).

The farms are full of allergens, dust particles of different sizes, endotoxins and chemical pollutants like toxic gases (Animal Confinement Gases, Pesticides). The effects of these deleterious elements may depend on the degree of exposure of the workers. For example, it has been found that lung function of grain workers is affected with time, depending on the exposure at the farms in which the individual worked. The present study therefore examines the influence of age, nature of job and duration of employment on respiratory parameters in a group of grain workers and sedentary subjects.

Future experimental and epidemiological studies can lead to a better understanding of the occupational hazards, which may cause respiratory diseases and establish a stronger link between the entity of respiratory disorders and specific occupations. Therefore, next to enlarging the epidemiological knowledge on the occupational contribution to the disease, experimental studies encompassing modern techniques from molecular biology, physiology and morphology should be used to identify a cellular basis of work-related respiratory diseases.
CONCLUSION

Findings reflect a need for continuing studies of health and safety issues affecting the subjects. The paucity of data concerning the health and safety of agricultural workers provides a strong rationale for rural health professionals to initiate research and educational programs focusing on health promotion/safety needs of agricultural workers.

References

5. Ramazzini B. [Diseases of workers], The Latin text of 1713 revised with translation and notes by Wilmer Cave Wright. The University of Chicago Press, Chicago, IL 1940.
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