The Effect of Ageing on Vital Capacity and Peak Expiratory Flow Rate in Healthy Non-Smoking Agricultural Workers

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ABSTRACT

Background: Agricultural workers have an increased risk of respiratory diseases. Occupation and age among many other factors influence the lung function. Growing body of scientific literature from oversees have highlighted the decline in lung function with age in farmers and farm related workers. The aim of the present study was to assess the age related decline in lung function in agricultural workers since most of the Indian studies reported age related decline in lung function in general population but none in agricultural population. Methods: A total number of 64 healthy, non-smoking agricultural workers were divided into two groups according to their age. First group consisted of 31 subjects aged between 20-25 years and the second group consisted of 33 subjects aged between 26-40 years. Vital capacity (VC) and Peak Expiratory Flow Rate (PEFR) were measured using spirometry in both the groups. Vital Index was calculated from the vital capacity and body surface area. Results: Peak Expiratory Flow Rate was decreased significantly with advancing age in agricultural workers but not the Vital Capacity. Conclusion: Both obstruction to the air flow and senile degenerative changes in the lungs together might have played a role in decreased PEFR in agricultural workers.

KEYWORDS: Age, Vital Capacity, PEFR, Agricultural Workers.
INTRODUCTION

Lung function in healthy non-smokers is affected by various factors, including but not limited to occupation, age, height, body surface area, gender, socio-economic status, ethnicity [1]. Respiratory diseases associated with agriculture were one of the first-recognized occupational hazards and they pose serious health problems in farmers or farm related workers [2,3]. 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 Arfificum [4]. In spite of this fact, few studies have concentrated on respiratory diseases affecting agricultural work force until 20th century [3]. Later, numerous studies (outside India) have demonstrated incidence of respiratory diseases in agricultural farmers or workers [5-16]. Agricultural workers have an increased risk of respiratory disease because they get exposed to a wide variety of toxic materials including dusts, gases, microbial products, toxins, pesticides and fertilizers [2,17,18,19].

Age and size of the farms also affect the lung function in agricultural workers. Distal airway obstruction is higher in older people who work on small farms [20]. Most of the studies either from India or from other countries have highlighted age related decline in lung function particularly, decline in VC [24-26], PEFR [27-37] and Forced Expiratory Volume in first second [22,34,38,39] in general population but none in agricultural population. It is well documented that as age advances there is a decrease in the elastic recoiling of the lungs, stiffening of the chest wall, reduced inspiratory muscle strength [22,40] which reduce the effective functioning of the lungs. To our knowledge none of the Indian studies have demonstrated and documented age related decline in lung function among agricultural workers. Therefore, the aim of the present study was to assess the age related decline in lung function in agricultural workers because understanding the effect of aging on the lung in them is important in order to distinguish pathologic changes from changes that are part of the normal aging process.

MATERIALS AND METHODS

Study population

A total number of 64 male healthy, non-smoking agricultural workers, who had no history of any skeletal deformities, cardiac and respiratory diseases, were recruited for this study. Occupation and nutritional status were enquired from all the subjects, using a questionnaire. The subjects were divided into two groups according to their age. First group consisted of 31 subjects aged between 20-25 years and the second group consisted of 33 subjects aged between 26-40 years. We have taken this age group range because earlier studies have reported that vital capacity and peak expiratory flow rate reaches peak somewhere around 20-40 years with inconsistent results [24,27,28,33,37,38,39]. Informed consent was taken from all the subjects and Institutional Human Ethical Committee clearance was obtained prior to start of the study and the study was conducted in Alluri Sita Ramaraju Academy of Medical Sciences (ASRAM) which is a tertiary care hospital in Andhra Pradesh, India.

Spirometric Measurements

Most commonly, the lung function is assessed by spirometry [41, 42] and the simple spirometry could detect mild airflow obstruction, even in asymptomatic patients [42]. The spirometry tests were conducted using Hutchinson’s Spirometer (Instruments & Chemical Pvt. Ltd, Ambala, India) for measuring the vital capacity (in liters) and Wright's mini Peak Flow Meter (Hudson Respiratory Care Inc. Temecula, U.S.A) was used for measuring the peak expiratory flow rate (liters per minute). We followed the procedures described in the earlier Indian studies [24, 27] and all the procedures were demonstrated to and practiced by the subjects before the beginning of the actual tests. For the Vital Capacity (VC), the subject was instructed to take a maximal inspiration, the mouth piece was placed firmly in the mouth and the subject was asked to breathe out maximally and rapidly till he was unable to expire anymore through the mouth piece. Importance was given to the volume of the breath rather than the speed of blowing. For the Peak Expiratory Flow Rate (PEFR) the subject was instructed to take a full deep breath and rapidly...
blow as fast as possible through the mouth piece of Wright’s mini peak flow meter. During testing the subjects were observed for coughing or wheezing. VC and PEFR were measured between 11:00 am-2:00pm, in standing position. Body Surface Area (BSA) was calculated from the formula of Dubois Nomogram.

**Vital Index** was calculated from the vital capacity and body surface area (BSA). Standing height and weight of the subjects were also measured without footwear. Each maneuver was performed repeatedly till the highest reading for VC and PEFR was obtained. To achieve error free recording of the forced expiratory parameters certain criteria were followed; maximal inhalation before the start of the test, satisfactory start of exhalation as shown by evidence of maximal effort, no hesitation during the expiratory effort and no cough or no glottal closure during the first second. No chance was given for leakage and it was made sure that there was no evidence of obstruction of the mouth piece. Nose clip was used while making the VC effort and for the PEFR measurement.

**Statistical Analysis**
The statistical analysis was performed using the SPSS 17 software (SPSS, Chicago). The effect of age on BSA, VC, VI and PEFR were analyzed in two groups using unpaired t test. The variables were expressed as the means and standard deviations, and p value less than 5% was considered statistically significant.

**RESULTS**
There was statically significant difference in age between the two groups. Table-1 shows that there was no significant comparison in body surface area, vital index, vital capacity between two groups. However, PEFR was decreased considerably which was statistically significant (p=0.01). That is, decline in PEFR was greater in aged agricultural workers.

Table 1: Comparison of BSA, VC, VI and PEFR between Group I (20-25 years of age) and Group II (26-40 years of age).

<table>
<thead>
<tr>
<th></th>
<th>Group I (n=31)</th>
<th>Group II (n=33)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSA</td>
<td>1.64 ± 0.13</td>
<td>1.70 ± 0.26</td>
<td>0.25</td>
</tr>
<tr>
<td>Vital Capacity</td>
<td>3.03 ± 0.43</td>
<td>2.96 ± 0.51</td>
<td>0.55</td>
</tr>
<tr>
<td>Vital Index</td>
<td>1.84 ± 0.23</td>
<td>1.74 ± 0.31</td>
<td>0.19</td>
</tr>
<tr>
<td>PEFR</td>
<td>541.93 ± 72.03</td>
<td>486.66 ± 93.32</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

*significance set at p value <0.05

**DISCUSSION**
Our findings reveal that there is a progressive decline in the PEFR with advancing age in healthy and non-smoking agricultural workers. Unexpectedly, decrease in vital capacity was not statistically significant in our study which is contrary to the previous studies [24-26]. Age related decline in PEFR is in corroboration with the previous authors [27-37]. However, none of the studies mentioned above were not conducted in agricultural workers. The decrease in PEFR could be due to distal airway obstruction as reported in earlier study [20]. Agricultural dusts, fumes, and gases can increase the airflow resistance [43] and organophosphate insecticides [44] may trigger bronchospasm in agricultural workers. Organophosphates inhibit acetyl cholinesterase and result in overstimulation of cholinergic receptors, presumably inducing bronchospasm by increasing the concentration of cyclic glucose monophosphate [3]. Airway narrowing caused by inflammation, edema, or smooth-muscle hyper reactivity results in acute and reversible decreases in airflow [3]. Nature and duration of exposure to these substances might as well determine the lung function in agricultural workers. Obstruction to airflow due to above
mentioned factors might have caused decrease in PEFR in our study along with age.

Apart from agriculture pollutants, the senile degenerative changes in the lungs viz., loss of respiratory muscle strength and stiffness of joint movements (decreased the mobility of the chest cage) are probably the most important factors reducing lung function with advancing age in agricultural workers. These factors limit ventilatory functions and thus cause a reduction in the total lung capacity and PEFR [22, 42]. The loss of elastic recoiling which limits the ventilatory function with advancing age may also be the reason for declining of lung function [22]. As age advances there is an oxidative damage that results in increased production of elastases which degrade elastic recoiling of the lung [45]. With age, the thorax is compressed and calcification of costal cartilage increases the severe kyphosis leading to loss of chest wall compliance and reduced diaphragmatic efficiency [46]. Both obstruction to the air flow and senile degenerative changes in the lungs together might have played role in decreased PEFR in agricultural workers.

CONCLUSIONS

Age no doubt plays an important role in determining the lung function both in general as well as in agricultural populations. However it is difficult to draw any definite conclusions from this study whether the natural advancing age or agricultural environment predisposing them to have decline in lung function because our study has the following limitations.

1. Sample size is too small.

2. There are many other spirometric measures apart from VC and PEFR which will have to be studied especially FEV1 and FEV1/FEV ratio.

3. We have used simple spirometer to measure VC and Wright’s Peak Flow Meter to measure PEFR due to non-availability of advanced equipment which would have given much detailed information with regard to lung function.

Therefore, further studies involving large population are clearly warranted understanding respiratory disease pattern due to agricultural exposures in aged individuals by filling the gaps in our knowledge.

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CONFLICT OF INTEREST: None identified

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