Original Article

เปรียบเทียบอาการและหน้าที่การทำงานของปอดในคนงานเผาถ่านและเกษตรกรสวนยาง

Comparison of symptoms and pulmonary function in charcoal production workers and rubber planters

วไลพร พราหมณ์ชู[1]
สีลม แจ่มอุลิตรัตน์[2]
ศรายุทธ ลูเซียนกีเตอร์[3]

Walaiporn Pramchoo[1]
Silom Jamulitrat[2]
Sarayut Lucien Geater[3]

[1]หน่วยอาชีวอนามัย ภาควิชาเวชศาสตร์ชุมชน [2]ภาควิชาเวชศาสตร์ชุมชน [3]ภาควิชาอายุรศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยสงขลานครินทร์ อ.หาดใหญ่ จ.สงขลา 90110

[1]Occupational Health and Safety Curriculum, Department of Community Medicine, [2]Department of Community Medicine, [3]Department of Internal Medicine, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, Thailand

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บทคัดย่อ:

ภูมิหลัง: อาชีพเผาถ่านเป็นอาชีพที่ต้องสัมผัสกับฝุ่นควัน ในปริมาณมาก โดยควันที่ฟุ้งออกมานี้เป็นสาเหตุในการก่อให้เกิดอาการเกี่ยวกับระบบทางเดินหายใจ

วัตถุประสงค์: เพื่อศึกษาสมรรถภาพปอดและอาการที่ผิดปกติเกี่ยวกับระบบทางเดินหายใจของคนงานเผาถ่านและศึกษาความแตกต่างของสมรรถภาพปอดระหว่างคนงานเผาถ่านกับเกษตรกรสวนยาง

วัสดุและวิธีการ: การศึกษาวิจัยทำโดยศึกษาและเปรียบเทียบสมรรถภาพปอดและอาการที่ผิดปกติเกี่ยวกับระบบทางเดินหายใจระหว่างคนงานเผาถ่านกับเกษตรกรสวนยาง

ผลการศึกษา: การศึกษาในครั้งนี้มีกลุ่มคนงานเผาถ่านและกลุ่มเกษตรกรสวนยาง กลุ่มละ 50 คน กลุ่มศึกษามีอาการไอ ร้อยละ 84 มีเสมหะ ร้อยละ 82 แน่นหน้าอกหายใจไม่สะดวก ร้อยละ 42 หายใจมีเสียงวี๊ด ร้อยละ 38 ระคายจมูก ร้อยละ 80 และมีอาการคัดจมูก น้ำมูกไหล ร้อยละ 26 ซึ่งสูงกว่ากลุ่มเปรียบเทียบอย่างมีนัยสำคัญ และคนงานเผาถ่านมีค่าเฉลี่ยของ ratio between the forced expiratory volume in one second and forced vital capacity (FEV_1/FVC%) และ Peak expiratory flow (PEF%) ต่ำกว่าเกษตรกรสวนยางอย่างมีนัยสำคัญทางสถิติ

สรุป: ควันไม้จากการเผาถ่านมีผลต่ออาการเกี่ยวกับระบบทางเดินหายใจและสมรรถภาพปอดของคนงานเผาถ่าน เพราะอาชีพเผาถ่านต้องสัมผัสกับฝุ่น ควัน ในปริมาณที่ค่อนข้างมาก และเกือบตลอดเวลาของการปฏิบัติงาน ดังนั้นฝุ่น ควัน จากการเผาไม้ให้กลายเป็นถ่านจึงก่อให้เกิดอันตรายต่อระบบหายใจของคนงานเผาถ่าน

คำสำคัญ: ขั้นตอนวิธีการเผาถ่าน, คนงานเผาถ่าน, ควันไม้

รับต้นฉบับวันที่ 8 เมษายน 2552 รับลงตีพิมพ์วันที่ 14 กรกฎาคม 2552

Abstract:

Background: Charcoal production workers work in conditions involving a high level of wood smoke. Wood smoke exposure in humans causes respiratory symptoms.

Objective: To study the pulmonary function and

respiratory symptoms of charcoal plant workers, and compare their pulmonary function with rubber planters.
Materials and methods: A comparative study was conducted to compare the pulmonary function and respiratory symtoms between charcoal workers and rubber planters.
Results: This study examined a total of 50 charcoal workers and 50 rubber planters. The charcoal workers were found to have significantly more coughs (84%), sputum production (82%), dyspnea (42%), wheezing (32%), nasal irritation (80%), and nasal congestion (26%) than the control group. The mean ± SD values of ratio between the forced expiratory volume in one second and forced vital capacity (FEV_1/FVC%) and Peak expiratory flow (PEF%) as determined by spirometer test in the charcoal workers were significantly lower than in the control group. The mean ± SD value of Peak expiratory flow (PEF) by peak flowmeter test in the charcoal workers.
Conclusion: The present study showed an association between wood smoke exposure in charcoal workers with respiratory symptoms and decreased pulmonary function, because the charcoal production process requires lengthy periods of curing during which a large amount of wood smoke is generated, which is breathed by the workers.

Key words: charcoal production, charcoal worker, wood smoke

Introduction

Air pollution from the wood smoke generated during the charcoal production process includes carbon monoxide, aldehydes, volatile organic and inorganic compounds, particulate matter and many other compounds.[1,2] Wood smoke exposure in humans causes respiratory effects, obstruction of the airway and decreased lung function. An earlier survey of respiratory effects and the pulmonary function of charcoal workers[3] showed that respiratory symptoms, spirometric parameters and the value of peak expiratory flow rate during the exposure to wood smoke were lower than before exposure. Similar results have been found in studies of women who use open cooking fires and firemen.[4-7] The association between wood smoke exposure and respiratory disease has been well established. The charcoal production process requires lengthy periods of curing during which large amounts of wood smoke are created with the duration of the exposure depending on various factors such as the size of the kiln and the density and freshness of the wood. During the burning period the charcoal workers are exposed to carbon monoxide, organic gases, particulate matter and other toxic compounds for several hours per day.[1] In this research, we studied the pulmonary function and respiratory symptoms of charcoal workers in southern Thailand, and compared their pulmonary function with rubber planters who were not exposed to the charcoal smoke.

Materials and methods

The present study was designed to compare pulmonary function of charcoal workers and rubber planters in Surat Thani province, Thailand. The subjects were charcoal workers in the study group and rubber planters in the control group, who had been working for more than 1 year and agreed to participate in the study. The sample size of 50 subjects in each group was arrived at based on the intended method of analysis at the 0.05 level of significance. The subjects in each group were matched for sex, age, and smoking because these are known factors related to pulmonary function. The questionnaire used for this study was adapted from the American Thoracic Society and Division of Lung Diseases of the National Heart and Lung Institute questionnaire (ATS-DLD-78-adult)[8] and British Medical Research Council (MRC)[9], and asked for general

demographic information, education, occupational history, respiratory symptoms, smoking habits, and other information related to lung disease.

Spirometry and Peak expiratory flow (PEF) measurements

Pulmonary function tests were performed by spirometry and measuring peak expiratory flow. Spirometry was measured using a spirometer (PONY FX, COSMED; Italy) which was calibrated daily. Each subject supplied at least three acceptable forced expiratory curves. The procedures adopted during the tests were in accordance with the procedure requirements and predicted values were calculated from the standardized lung function testing guidelines of the Thoracic Society of Thailand.[10] Peak expiratory flow (PEF) was measured using a peak flowmeter (Micro Peak; Kent, UK) with a range from 60 to 900 L/min. The meter was sterilized after each test. Each subject was measured in the morning before they started work, at midday, in the evening after they finished work, and finally before going to bed, and all measurements were recorded. Testing was carried out over 14 days, with the first 3 days being non-working days, and the final 11 days during the period of exposure. Each PEF, four times daily, approximately at similar times, was performed three times on each occasion and the best of the three values was recorded. Any respiratory symptoms such as cough, sputum production, dyspnea, wheezing, nasal irritation, or nasal congestion were noted in the record sheet.

Statistical analysis

A comparison of case and control characteristics was conducted using the McNemar chi-square for discrete variables, the paired t-test for continuous variables and the mean values of spirometric variables. The results of the PEF measurements were analyzed by the generalized estimating equation. The mean values were recorded as standard deviation. $p < 0.05$ was taken as significant.

Results

General characteristics

A total of 50 cases and 50 controls were enrolled. The distribution by case and control subject status for general variables is shown in Table 1. The case group had a lower average education than the control group. Sex, age, and smoking habits were matched between the groups to allow better comparison of the studied variables. The charcoal workers were found to have significantly more coughs (84%), sputum production (82%), dyspnea (42%), wheezing (32%), nasal irritation (80%), and nasal congestion (26%) than the control group. Mild, obstructive lung function was found in 2% of the study group but not in the control group.

Spirometry and PEF measurements

The mean (±SD) values of the pulmonary function test by spirometer of the charcoal workers and rubber planters are shown in Table 1. The mean (±SD) values of FEV_1/FVC% and PEF% in the charcoal workers were significantly lower than in the control group. The mean ± SD of the peak expiratory flow values (PEF) by peak flowmeter test of the charcoal workers and rubber planters in the morning, at midday, in the evening, and before bedtime are shown in Figure 1. The mean PEFs in charcoal workers at all times for the working period were lower than in the rubber planters,

Table 1 Comparing the characte istics, obstructive airway diseases, respiratory symptoms and mean (±SD) values of the spirometric indexes of charcoal workers and rubber planters

	Charcoal workers (n=50)	Rubber planters (n=50)	p-value*
Sex*			
Male	28 (56%)	28 (56%)	-
Age (yrs)*	33.5 ± 8.8	34.3 ± 9.3	-
High (c.m.)	161.8 ± 8.2	164.6 ± 6.3	0.06
Education			<0.001
None	1 (2%)	-	-
Primary school	48 (96%)	24 (48%)	-
Secondary school	1 (2%)	26 (52%)	-
Smoking*			
Never	18 (36%)	18 (36%)	-
Smoking every day	5 (10%)	5 (10%)	-
Smoking infrequent	27 (54%)	27 (54%)	-
Pack years	7.3 ± 9.5	8.2 ± 9.7	-
Obstructive airway diseases			
Normal	49 (98%)	50 (100%)	0.5
Mild obstructive	1 (2%)	-	0.5
Respiratory symptoms			
Cough	42 (84%)	12 (24%)	<0.001
Sputum production	41 (82%)	24 (48%)	0.0005
Dyspnea	21 (42%)	6 (12%)	0.003
Wheezing	16 (32%)	1 (2%)	<0.001
Nasal irritation	40 (80%)	4 (98%)	<0.001
Nasal congestion	13 (26%)	-	0.0002
FVC%‡	101.4 ± 1.5	102.3 ± 1.6	0.7
FEV_1%†	99.9 ± 1.5	103.6 ± 1.7	0.07
FEV_1/FVC%**	96.5 ± 1.0	99.0 ± 0.7	0.04
FEF_{25-75}%***	88.9 ± 3.0	94.3 ± 2.7	0.2
PEF%****	142.5 ± 5.2	153.8 ± 3.8	0.05

*Variables were matched in case and control groups

‡Forced vital capacity

†Forced expiratory volume in one second

**Ratio between the forced expiratory volume in one second and forced vital capacity

***Forced expiratory flow at 25–75% of FVC

****Peak expiratory flow

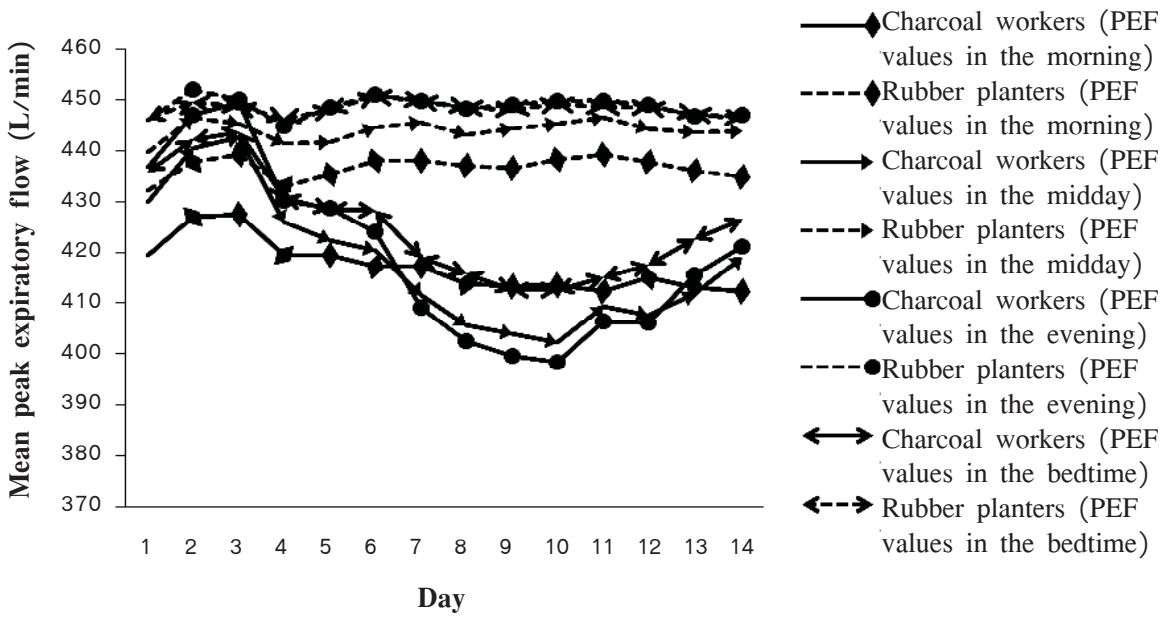

Figure 1 Comparing the PEF values from morning, midday, evening, and bedtime in charcoal workers and rubber planters

especially during either the open or closed tunnel burning periods, when the PEFs of charcoal workers at all tested times were significantly lower than in the rubber planters.

Discussion

In the present study, wood smoke exposure was associated with more respiratory symptoms, including cough, sputum production, dyspnea, wheezing, nasal irritation, and nasal congestion and a relatively lower pulmonary function. The potentially confounding effects of sex, age, and smoking were controlled by matching subjects in the study and control groups at selection.

The charcoal workers had significantly lower values between the forced expiratory volume in one second and forced vital capacity (FEV_1/FVC%) and Peak expiratory flow (PEF%) than the control group, although only 1 charcoal worker had a lung function abnormality, and that was only mild obstructive airway disease. In a cross sectional survey from western India, Saha et al.[6] found that biomass fuel use (especially wood) is an important factor in deterioration of pulmonary function. Forced expiratory volume in one second (FEV_1%) and PEF values were significantly lower in females who used biomass fuels than in females who used Liquefied petroleum gas (LPG). Brunekreef et al.[11] found a strong association between chronic obstructive pulmonary disease (COPD) and wood and charcoal smoke exposure after adjusting for age and smoking. In addition, another study on the effects of long-term exposure of inhaled particulate matter demonstrated an association between respiratory symptoms and decreased lung function.[12] In this study, the PEF values in charcoal workers

measured at morning, midday, evening, and bedtime for working period were all lower than in the rubber planters. Especially for burning period either open tunnel and close tunnel the PEF of charcoal workers in morning, midday, evening, and bedtime were significantly lower than rubber planters.

The PEF of the charcoal workers was lower than the rubber planters because the charcoal production process involves a high level of wood smoke, especially during either the open or closed tunnel burning period when the wood smoke was highest. Although the charcoal workers tried to avoid the smoke when possible, exposure was frequently unavoidable, as another study of charcoal workers by Tzanakis[3] also found. The mean PEFs at midday and in the evening during the exposure period were significantly lower than the morning measurements, before the workers faced their daily exposure to the wood smoke. A significant association between exposure to wood smoke and respiratory symptoms appears to be confirmed in our study, which is consistent with other reports.[13-16] Wood smoke exposure causes a decreased lung function and increased respiratory symptoms. Wood smoke generates a complex mixture composed of liquids, solids, and gaseous particles, many of which are irritants and genotoxic, such as carbon monoxide, nitrogen and sulphur oxides, benzene, methanol, styrene, phenols, aldehydes, organic acid, and polycyclic aromatic hydrocarbons.[1,2] In this study, the charcoal workers were exposed to wood smoke for a long time, approximately 8 to 9 hour/day for a total of 3 to 4 months. The irritants in wood smoke noted above contribute to health problems in the respiratory tract by interfering with the cilia and disrupting the flow of the particle-trapping mucus stream,[2] explaining the increased cough, sputum production, dyspnea, and nasal irritation in charcoal workers. Many studies have confirmed the negative impact of prolonged wood smoke inhalation and the relationship to increased respiratory symptoms and decreased lung function.

Conclusion

This study found an association between wood smoke exposure in charcoal workers and respiratory symptoms and decreased pulmonary function. Future prospective studies should be conducted to conclusively identify the factors in wood smoke related to respiratory disease and decreased pulmonary function.

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