



Lung function and respiratory symptoms in charcoal workers in southern Brazil: an eight-year cohort study

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TO THE EDITOR:

In southern Brazil, charcoal production is an artisanal, nonmechanized process that involves felling trees, transporting logs, burning wood in brick kilns, and monitoring the wood burning process. Workers are exposed to charcoal smoke and dust, often with no personal protective equipment. The kilns are family owned and located adjacent to their dwellings, likely leading to lifetime exposure. The objective of the present study was to assess whether there were significant changes in respiratory symptoms and spirometry results after an eight-year period.

In 2008, we evaluated 67 individuals working at 41 kilns, the mean number of years working at kilns being 19.1 years.⁽¹⁾ Participants completed a structured questionnaire and underwent spirometry. Of the 67 workers evaluated in 2008, 9 had obstructive lung disease, as assessed by spirometry. Of those, 5 were diagnosed with bronchial asthma and 4 were diagnosed with COPD. In addition, 4 participants (5.8%) died and 1 (1.5%) was lost to follow-up. In 2016, 62 individuals (92.5%) were located for follow-up. Of those, 11 (16.4%) declined to participate. Therefore, 51 (82.2%) completed the questionnaire and underwent spirometry again. All spirometry tests were performed with a Microlab 3500 spirometer (Micro Medical Ltd., Rochester, England) before and after administration of a bronchodilator (400 µg of albuterol). All procedures were performed in accordance with the American Thoracic Society/European Respiratory Society guidelines.⁽²⁾ The study was approved by the local research ethics committee (CAAE no. 50237415.5.0000.5348). All participants gave written informed consent.

Normality of data distribution was assessed with the Kolmogorov-Smirnov test. Continuous variables were presented as means and standard deviations, and the Student's t-test was used in order to assess changes in spirometric variables. Descriptive statistics (absolute and relative values) were calculated, and McNemar's test was used in order to assess changes in respiratory symptoms. The level of significance was set at 0.05. All statistical analyses were performed with the IBM SPSS Statistics software package, version 24.0 (IBM Corporation, Armonk, NY, USA).

Of the 67 individuals who were evaluated in 2008, 51 (80.9%) were evaluated again in 2016, the mean age being 54 ± 13 years. Of those 51 individuals, most (n = 38; 74.5%) were male. In addition, 35 (68.6%) remained as charcoal workers, whereas 16 (31.4%) did not. The

most common upper airway symptoms were sneezing, in 35 (68.6%); nasal obstruction, in 14 (27.5%); and nasal discharge, in 13 (25.5%). The most common lower airway symptoms were cough, in 14 (27.5%); expectoration, in 19 (37.3%); and chronic expectoration, in 8 (15.7%). The prevalence of respiratory symptoms did not change after eight years, the exception being that of sneezing, which increased from 39.2% in 2008 to 68.6% in 2016 (p < 0.05).

Lung volumes were found to have decreased after eight years of exposure in smokers and nonsmokers alike. In both subgroups, there was a significant reduction in FVC in liters and as a percentage of the predicted value, as well as in FEV₁ in liters. All 51 workers showed a decline of 48 mL/year in pre-bronchodilator FVC and of 37 mL/year in pre-bronchodilator FEV₁. Nonsmokers showed a mean decline of 44 mL/year in FVC and of 35 mL/year in FEV₁. Smokers experienced a significant decrease in mean FVC and FEV₁ (58 mL/year and 39 mL/year, respectively). It is of note that the participants who remained as charcoal workers and those who were smokers experienced a more pronounced decline in FVC and FEV₁ after bronchodilator administration. Among workers ≥ 40 years of age (n = 44), there was no significant decrease in FVC after eight years, but there was a significant decrease in FEV₁. After bronchodilator administration, there was a significant decrease in mean FVC and FEV₁ (65 mL/year and 45 mL/year, respectively; p < 0.001 for both). Table 1 shows the changes in spirometric values over the course of eight years, by sex, work status (i.e., still working in the production of charcoal or no longer working in the production of charcoal), smoking status, and age.

Our study showed a significant decrease in lung volumes (i.e., a decrease of 51 mL/year in FVC and of 38 mL/year in FEV₁) after bronchodilator administration. Reduced lung capacity is associated with aging and is an expected physiological outcome in most individuals,⁽³⁾ being influenced by the environment and, in particular, air quality. One study⁽⁴⁾ examined lung function and showed that a decline of ≤ 20 mL/year in FEV₁ can be considered normal in individuals ≤ 40 years of age. In individuals > 40 years of age, a decline of approximately 38 mL/year in FEV₁ can be considered normal.⁽⁴⁾ In the present study, however, 7 (13.7%) of the workers who were ≤ 40 years of age experienced a decline of 62 mL/year in FEV₁ after bronchodilator administration. This suggests that working in charcoal production can lead to a more pronounced decline in FEV₁ over time.

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Table 1. Changes in FEV₁ (in mL/year) and FVC (in mL/year) in charcoal workers in Brazil in the 2008-2016 period, by smoking status, work status (i.e., still working/no longer working in charcoal production), sex, and age.

Variable	n	Pre-bronchodilator				Post-bronchodilator			
		ΔFEV ₁	p	ΔFVC	p	ΔFEV ₁	p	ΔFVC	p
Total sample	51	-37	< 0.001	-48	< 0.001	-38	< 0.001	-51	< 0.001
Smoking status									
Nonsmoker	37	-35	< 0.001	-44	< 0.001	-34	< 0.001	-43	< 0.001
Smoker	14	-39	< 0.002	-58	< 0.001	-50	< 0.001	-72	< 0.001
Working in charcoal production in 2016									
No	16	-28	< 0.006	-45	< 0.003	-35	< 0.008	-42	< 0.023
Yes	35	-39	< 0.001	-49	< 0.001	-40	< 0.001	-54	< 0.001
Working in charcoal production in 2016 + smoking status									
No + nonsmoker	09	-17	< 0.079	-24	< 0.086	-21	< 0.053	-16	< 0.408
No + smoker	07	-43	< 0.037	-72	< 0.016	-53	< 0.050	-73	< 0.028
Yes + nonsmoker	28	-40	< 0.001	-51	< 0.001	-37	< 0.001	-50	< 0.001
Yes + smoker	07	-35	< 0.037	-45	< 0.064	-48	< 0.003	-70	< 0.002
Sex									
Male	38	-36	< 0.001	-48	< 0.001	-42	< 0.001	-65	< 0.001
Female	13	-31	0.001	-45	< 0.001	-37	0.001	-61	0.001
Age									
≤ 40 years	7	-36	0.009	-18	0.008	-62	0.001	-37	< 0.001
> 40 years	44	-35	0.010	-53	0.055	-45	< 0.001	-65	< 0.001

Participants > 40 years of age had a decline of 45 mL/year in FEV₁ after bronchodilator administration. Charcoal workers are similar to firefighters in terms of occupational smoke exposure. In a study evaluating 1,146 firefighters in the USA over a three-year period in the 1970s, FEV₁ and FVC were found to have decreased by 30 mL/year and 40 mL/year, respectively.⁽⁵⁾

Our study has two major limitations: 19% of the original sample was lost to follow-up, and the absence of a control group precluded comparisons with individuals

not exposed to charcoal smoke/dust. Nevertheless, the present study presents interesting data regarding a very common occupation in Brazil, comparing spirometry results over an eight-year period.

In conclusion, although charcoal workers showed no increase in respiratory symptoms (except for sneezing), there was a reduction in lung volumes over the course of eight years, especially in those who were smokers and ≤ 40 years of age.

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