

Original Article

Comparative study of respiratory symptoms and lung function alterations in patients with chronic obstructive pulmonary disease related to the exposure to wood and tobacco smoke*

Estudo comparativo de sintomas respiratórios e função pulmonar em pacientes com doença pulmonar obstrutiva crônica relacionada à exposição à fumaça de lenha e de tabaco

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Abstract

Objective: To describe and analyze clinical symptoms and spirometric alterations of patients with chronic obstructive pulmonary disease (COPD) and history of exposure to wood and tobacco smoke. **Methods:** We retrospectively evaluated data related to 170 patients distributed into 3 groups: 34 exposed only to wood smoke, 59 patients exposed only to tobacco smoke and 77 patients exposed to both. **Results:** The groups did not differ significantly in terms of age ($p = 0.225$) or degree of exposure, considering each type of exposure in isolation or in combination ($p = 0.164$ and $p = 0.220$, respectively). Females predominated in the group exposed to wood smoke. There were no differences among the groups regarding respiratory symptoms ($p > 0.05$), and moderate dyspnea predominated in the three groups ($p = 0.141$). The group exposed to wood smoke presented higher percentages of forced expiratory volume in one second/forced vital capacity ratio and of forced expiratory volume in one second ($p < 0.05$). Positive results on bronchodilator testing occurred more frequently in the group exposed to tobacco smoke. The percentage of severe and extremely severe obstruction was significantly higher in the group exposed to tobacco smoke (44.1%) than in that exposed to wood smoke (11.8%; $p = 0.006$). **Conclusions:** Respiratory symptoms and pulmonary function alterations consistent with COPD were observed in the groups of patients exposed to wood smoke. However, those alterations were not as significant as the alterations observed in the groups exposed to tobacco smoke. This study emphasizes the importance of prospective studies in evaluating the risk of wood-smoke-related COPD in Brazil, as well as the need for preventive measures in this area.

Keywords: Pulmonary disease, chronic obstructive; Smoking; Air pollution, indoor; Smoke.

Resumo

Objetivo: Descrever e analisar sintomas respiratórios e alterações espirométricas em pacientes portadores de doença pulmonar obstrutiva crônica (DPOC), com história de exposição à fumaça de lenha e de tabaco. **Métodos:** Foram avaliados retrospectivamente dados de 170 pacientes distribuídos em 3 grupos: 34 pacientes expostos somente à fumaça de lenha, 59 pacientes, somente à de tabaco e 77 pacientes expostos a ambas. **Resultados:** Os grupos não diferiram quanto a idade ($p = 0,225$) e grau de exposição, considerando cada tipo de exposição isoladamente ou em associação ($p = 0,164$ e $p = 0,220$, respectivamente). No grupo exposto à fumaça de lenha predominou o sexo feminino. Não houve diferença entre os grupos quanto à frequência dos sintomas respiratórios ($p > 0,05$), e houve predominância de grau moderado de dispnéia nos três grupos ($p = 0,141$). O grupo exposto à fumaça de lenha apresentou melhores percentuais da relação volume expiratório forçado no primeiro segundo/capacidade vital forçada e de volume expiratório forçado no primeiro segundo ($p < 0,05$). A prova broncodilatadora positiva ocorreu com maior frequência no grupo exposto ao tabaco. O percentual de obstrução brônquica grave e muito grave foi significativamente maior no grupo exposto ao tabaco (44,1%) que no grupo exposto somente à fumaça de combustão de lenha (11,8%; $p = 0,006$). **Conclusões:** Os sintomas respiratórios e alterações da função pulmonar compatíveis com DPOC foram observados nos grupos expostos à fumaça de lenha. Todavia, estas alterações foram menos intensas do que as observadas nos grupos expostos ao tabaco. Este trabalho ressalta a importância de realizar-se um estudo prospectivo para avaliar o risco de DPOC associado à exposição à fumaça de lenha no Brasil assim como a necessidade de ações preventivas neste âmbito.

Descritores: Doença pulmonar obstrutiva crônica; Tabagismo; Poluição do ar em ambientes fechados; Fumaça.

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Introduction

The wood stove is an element that is still quite common in the rural areas of Brazil. It is widely used in the central-west region of Brazil. This type of stove is generally placed inside the house, in rooms with poor ventilation and with insufficient venting, which facilitates the propagation of smoke to the other rooms, extending the exposure to all dwellers.

The Brazilian Institute of Geography and Statistics⁽¹⁾ estimated the percentage of dwellings using wood as fuel in Brazil in 2003 at 8.6%.

Considered as a risk factor for chronic obstructive pulmonary disease (COPD),⁽²⁾ exposure to wood smoke has been evaluated in a number of studies, many of which were carried out in Latin America.⁽³⁻⁷⁾ In a study carried out in Bogota, Columbia,⁽³⁾ it was concluded that exposure to wood smoke was associated with the presence of obstructive airway disease among low-income women, which could explain up to 50% of all cases.

In Brazil, there have been few studies on COPD in individuals exposed to smoke from wood stoves. In the bibliographic sources researched, two Brazilian studies are registered: the study designated the *Proyecto Latinoamericano de Investigación en Obstrucción Pulmonar* (PLATINO, Latin-American Project for the Investigation of Pulmonary Obstruction),⁽⁸⁾ which sampled a population in the city of São Paulo, Brazil; and a study which referred to risk factors of COPD in the urban area of Pelotas, Brazil.⁽⁹⁾

In the state of Goiás, Brazil, where agricultural activity is a strong component of the economy, rural origin is usual, even among inhabitants of the largest cities of the state. The use of wood stoves is still relatively common in the rural area, being also used in the urban areas of countryside towns, although probably less frequently so, given the Brazilian data available (40.9% among the rural population and 2.6% among the urban population).⁽¹⁾ Studies on the effects of wood smoke in these populations are called for, given the frequent use of wood stoves and the resulting ill effects on health.

The objective of the present study was to describe and analyze respiratory symptoms and pulmonary function alterations in patients with COPD residing in Goiás, Brazil and exposed to wood smoke in comparison with data obtained for COPD

patients exposed to tobacco smoke, as well as for COPD patients exposed to both.

Methods

We evaluated symptoms and spirometry data of 887 patients who underwent spirometry at the Pulmonary Function Laboratory of the *Hospital das Clínicas da Universidade Federal de Goiás* (HC/UFG; Federal University of Goiás *Hospital das Clínicas*) between 2004 and 2006, obtained from the laboratory files. Clinical data were collected from a standardized respiratory questionnaire recommended in the *Sociedade Brasileira de Pneumologia e Tisiologia* (SBPT; Brazilian Thoracic Association) guidelines for use in pulmonary function laboratories.⁽¹⁰⁾ This questionnaire is filled out by the technician at the time of the examination.

Spirometric tests were performed by professionals with a certification in spirometry issued by the SBPT. The specific SPBT and American Thoracic Society guidelines were followed.^(10,11) In order to perform the bronchodilator testing, 400 µg of albuterol were administered to the patient using a metered-dose inhaler with a spacer.

The spirometers used were Masterscreen (Jaeger, Würzburg, Germany) and Vmax 22 (SensorMedics, Yorba Linda, CA, USA), daily calibrated and recalibrated when the equipment software required. Knudson's predicted values were used.⁽¹²⁾

From the respiratory questionnaire, we obtained information on symptoms (cough, sputum, wheezing), intensity of dyspnea using the modified Medical Research Council scale, quantification of the exposure to tobacco smoke through active smoking, and quantification of the exposure to wood smoke and to other inhaled substances, such as dust and chemicals, reported by the patient. No specific occupational questionnaire was used.

The cumulative exposure to tobacco smoke was quantified using pack-years, and exposure to wood smoke was expressed in hour-years, calculated as the number of years cooking with a wood stove multiplied by the mean number of hours the patient reported to spend, daily, in this activity.⁽¹³⁾

We considered the following as diagnostic criteria for COPD: patients aged 40 years or older; postbronchodilator ratio between forced expiratory volume in one second and forced vital capacity (FEV₁/FVC) < 70% of the predicted value; tobacco

intake > 20 pack-years or exposure to wood smoke > 80 hour-years; history of dyspnea or cough.^(4,13,14) The classification in levels of severity was based on FEV₁.⁽¹⁰⁾ The criterion of exposure to wood smoke > 80 years-age used in this study was based on the levels of exposure considered significant in similar studies.^(13,15)

We used the following as exclusion criteria: variation of FEV₁ after bronchodilator use (albuterol 400 µg) ≥ 10%; medical indication of examination for asthma or for other pulmonary diseases other than COPD; and report of occupational exposure to silica or asbestos.

We included data of patients from the outpatient clinics of the HC/UFG and from public health care facilities who are sent for examination at this hospital.

From the total of 887 patients, we selected 170 (19.2%) who met the inclusion/exclusion criteria and whose data were complete. The selected group was divided in 3 subgroups according to the type of exposure: 1) exposed only to wood smoke; 2) exposed to tobacco and wood smoke; 3) exposed only to tobacco smoke.

In the comparative analysis of the groups for the measurable variables, we used the analysis of variance and Tukey's test for the minimum significant difference. The chi-square test was used for quantitative variables.

In the evaluation of dyspnea among groups, the Kruskal-Wallis test was used.

In order to evaluate the risk for the occurrence of severe disease in the tobacco and wood groups, logistic regression analysis was used. In order to study the possible influence of duration of exposure on the spirometric variables, linear regression analysis was used.

This study was approved by the Human and Animal Ethics in Research Committee of the HC/UFG on 13 August 2007 (Protocol no. 122/07).

Results

A total of 170 patients were selected for the retrospective data analysis, of which 34 were exposed only to wood smoke, 77 were exposed to tobacco and wood smoke, and 59 were exposed only to tobacco smoke.

Analyzed as to mean age, the groups proved to be homogeneous. Mean age was 68.4 ± 8.1 years in the group exposed only to wood smoke, 65.8 ± 10.00 in the group exposed to wood/tobacco smoke and 64.9 ± 9.1 years in the group exposed only to tobacco smoke (p = 0.225). Female patients predominated in the wood smoke only group (85.3%) and in the wood/tobacco smoke group (51.9%). The percentage of male patients was 86.4% in the group exposed only to tobacco smoke. This difference was statistically significant (p < 0.001; Table 1).

The intensity of exposure to tobacco smoke measured in pack-years and to wood smoke in hour-years did not differ among the groups, considering each kind of exposure in isolation or in association (p = 0.164 and p = 0.220, respectively). In the group exposed only to wood smoke and in the one exposed to wood and tobacco smoke, the intensity of the exposure to wood smoke was 212.8 ± 103.53 hour-years and 187 ± 97.31 hour-years, respectively. In the group exposed only to tobacco smoke and in the group exposed to wood and tobacco smoke, the intensity of the exposure to tobacco smoke was 59.3 ± 37.6 pack-years and 51.83 ± 24.2 pack-years, respectively.

Table 1 - Distribution of patients according to gender, age and type of exposure.

Parameters	Wood smoke (n = 34)	Tobacco smoke (n = 51)	Tobacco + wood smoke (n = 47)	p
Gender				
Female	29 (85.3%)	8 (13.6%)	40 (51.9%)	<0.001*
Male	5 (14.7%)	51 (86.4%)	37 (48.1%)	
Age, mean ± SD	68.4 ± 8.1	64.9 ± 9.1	65.8 ± 10.0	0.225**
Duration of exposure ^a				
pack-years, mean ± SD	-	59.3 ± 37.6	51.8 ± 24.2	0.164**
hour-years, mean ± SD	212.9 ± 103.5	-	187.7 ± 97.3	0.220**

^aDuration of exposure: wood smoke in hour-years and tobacco smoke in pack-years. *Chi-square test. **Analysis of variance.

When analyzed as to symptoms of cough, wheezing and presence of sputum, no statistically significant difference was observed among the groups (the values as to symptoms were, respectively, $p = 0.845$; $p = 0.968$; and $p = 0.894$). In all groups, the dyspnea observed was most often moderate (grade 2; $p = 0.141$). No significant difference in the frequency of dyspnea, regardless of grade, was observed among the groups (Table 2). On some questionnaires, answers to a number of items were missing, and the samples therefore differ from the total number for many of these items.

The values found for FVC and FEV₁, as well as for the FEV₁/FVC ratio, are shown in Table 3. The three groups studied did not differ as to the percentage of FVC prior to the use of the bronchodilator ($p = 0.269$). The group exposed only to wood smoke presented higher values of FEV₁ and of postbronchodilator FEV₁/FVC ratio, in percentages of the predicted values, in relation to the other groups ($p = 0.001$ and $p = 0.005$, respectively). There were no statistically significant differences as to these variables between the group exposed only to tobacco smoke and the group exposed to wood and tobacco smoke.

Positive response to bronchodilator was observed in 25.4% of the patients of the group exposed only to tobacco smoke, percentage significantly higher in relation to the group exposed only to wood smoke and to the group exposed to wood and tobacco smoke (5.9 and 9.1%, respectively; $p = 0.008$).

The groups present differences as to the severity of COPD, considering postbronchodilator FEV₁ as the severity criterion. In the group exposed only to tobacco smoke, 44.1% of the patients presented severe or extremely severe disease, compared with 11.8% in the group exposed only to wood smoke ($p = 0.006$). The odds ratio for severe or extremely severe disease was approximately six times higher in the group exposed only to tobacco smoke (OR = 5.909; 95% CI: 1.847-18.907; Table 4).

The degree of exposure was not found to correlate with the postbronchodilator values of the FEV₁/FVC ratio and FEV₁ in any of the groups ($p > 0.05$; Table 5).

Discussion

It is estimated that approximately 17.0% of Brazilian homes have wood stoves and 97.5% have

Table 2 – Frequency of respiratory symptoms according to the type of exposure.

	Tobacco smoke		Wood smoke		Tobacco + wood smoke		p
	n	%	n	%	n	%	
Sputum							
No	21	42.9	11	37.9	26	39.4	0.894*
Yes	28	57.1	18	62.1	40	60.6	
Total	49	100.0	29	100.0	66	100.0	
Wheezing							
No	25	43.9	15	44.1	34	45.9	0.968*
Yes	32	56.1	19	55.9	40	54.1	
Total	57	100.0	34	100.0	74	100.0	
Cough							
No	18	30.5	10	29.4	26	34.2	0.845*
Yes	41	69.5	24	70.6	50	65.8	
Total	59	100.0	34	100.0	76	100.0	
Dyspnea ^a							
0	3	5.2	1	2.9	2	2.6	0.462**
1	13	22.4	2	5.9	18	23.7	
2	20	34.5	22	64.7	33	43.4	
3	13	22.4	4	11.8	9	11.8	
4	9	15.5	5	14.7	14	18.4	
Total	58	100.0	34	100.0	76	100.0	

^aModified Medical Research Council scale. *Chi-square test. **Kruskal-Wallis test.

Table 3 - Spirometric parameters in the different groups.

Variable	n	Mean	SD	F*	p
% FVC pre-bd					
Tobacco smoke	59	99.05	22.93		
Wood smoke	34	106.58	24.95	1.324	0.269
Tobacco + wood smoke	77	103.52	21.17		
% FEV ₁ /FVC post-bd**					
Tobacco smoke ^C	59	46.42	13.10		
Wood smoke ^D	34	56.93	11.14	7.273	0.001
Tobacco + wood smoke ^C	77	49.31	13.45		
% FEV ₁ post-bd**					
Tobacco smoke ^H	59	60.56	22.73		
Wood smoke ^J	34	77.33	22.99	5.383	0.005
Tobacco + wood smoke ^H	77	66.07	24.84		

*Analysis of variance. **Same letters indicate absence of significant difference among the groups, using the Tukey test. F: F value (analysis of variance); FVC: forced vital capacity; bd: bronchodilator; and FEV₁: forced expiratory volume in one second.

gas stoves. Approximately 8 million residents use both types of fuel. In recent years, with the increase in the propane gas price, a tendency to return to the use of wood for cooking has been observed. In 2003, the use of wood as the principal fuel predominated in 1% of socioeconomic class A and B residences, in 3% of socioeconomic class C residences, 7% of socioeconomic class D residences and 17% socioeconomic class E residences.^(1,16) The percentage of homes, considering the urban and rural areas, which use predominantly wood is higher than in other regions and above the Brazilian mean in the central-west region, followed by the south region. That percentage is lower than in other regions and below the Brazilian mean in the southeast and north of Brazil, excluding, in the latter, the rural area of some states.⁽¹⁶⁾

The principal determiners of the selection of a small percentage, lower than 20% of the initial sample, were the retrospective design of the study, insufficient data in the files and the exclusion of patients with asthma and lung diseases other than

COPD. Other important exclusion factors were tobacco intake < 20 pack-years and exposure to wood smoke < 80 hour-years. We opted to use a postbronchodilator FEV₁/FVC ratio < 70% as the spirometric criterion for the definition of COPD, since it is a simple definition, which dispenses with predicted values for each studied population and which has been widely used in other studies.

Some limitations of the present study must be highlighted. It was a retrospective study, with data collection from questionnaires filled out by spirometry technicians. All technicians at the Pulmonary Function Laboratory of the HC/UFG are certificated by the SBPT. The questionnaire is standardized and systematically filled out for all patients who undergo spirometric testing, always by the same technicians. The medical team periodically supervises questionnaire completion. Although this questionnaire includes questions on occupational exposure, it does not detail or quantify such exposure, which prevented us from establishing a relationship with the presence of obstruction.

Table 4 - Severity of chronic obstructive pulmonary disease and type of exposure.

	Tobacco smoke		Wood smoke		p*	OR	OR (95% CI)	
	n	%	n	%			min	max
FEV ₁ post-bd								
>50.0% (mild and moderate)	33	55.9	30	88.2	-	-	-	-
<50.0% (severe and extremely severe)	26	44.1	4	11.8	0.003	5.909	1.847	18.907
Total	59	100.0	34	100.0	-	-	-	-

*Logistic regression analysis; min: minimum; max: maximum; FEV₁: forced expiratory volume in one second; and bd: bronchodilator.

Table 5 – Influence of duration of exposure on spirometric alterations.

Exposure	b ¹	t	p*
FEV ₁ /FVC post-bd			
Tobacco smoke			
Tobacco smoke only	0.016	1.388	0.167
Tobacco and wood smoke	-0.084	-1.335	0.186
Wood smoke			
Wood smoke only	-0.004	-0.219	0.828
Tobacco and wood smoke	0.013	0.817	0.417
FEV ₁			
Tobacco smoke			
Tobacco smoke only	0.013	0.621	0.536
Tobacco and wood smoke	-0.154	-1.320	0.191
Wood smoke			
Wood smoke only	0.052	1.369	0.180
Tobacco and wood smoke	-0.002	-0.071	0.943

*Linear regression analysis. b¹: slope coefficient adjustment; t: critical t value (Student's t-test); FEV₁/FVC: forced expiratory volume in one second and forced vital capacity ratio; and bd: bronchodilator.

The predominance of female patients in the two groups exposed only to wood smoke was expected, since domestic exposure takes place especially during cooking, a task traditionally relegated to women. Even in countries where biomass burning is also used for room heating, women are more exposed.⁽¹³⁾

There were no differences among the groups in terms of sputum production, cough and wheezing. A study carried out in Mexico⁽¹³⁾ showed a similar result. However, in studies carried out in Colombia⁽¹⁵⁾ and India,⁽¹⁷⁾ the percentage of symptoms was higher among women exposed only to wood smoke than among those who were smokers and were not exposed to wood smoke. Differences in the intensity of exposure and the type of vegetation used as fuel might have been responsible for the differences among the studies.

In the present study, the dyspnea observed was predominantly moderate in all three groups. Considering FEV₁ as a criterion, the severity index was different among the three groups. This finding can, in part, be related to the subjectivity of the grading of this symptom by the patient or to the limitation of the qualitative evaluation method adopted. We observed that the group exposed only to wood smoke presented better FEV₁ and FEV₁/FVC ratio. In addition, fewer patients in that group were classified as severe and extremely severe.

As in the present study, the authors of two other studies found a tendency toward lower

severity of the obstruction in individuals exposed only to wood smoke, in relation to those exposed only to tobacco smoke.^(13,15) In only one of those studies,⁽¹⁵⁾ however, hypoxemia, hypercapnia, and pulmonary hypertension were observed in patients with pronounced bronchial obstruction exposed only to wood smoke. The diffusing capacity of the lung for carbon monoxide in patients with COPD due to wood smoke exposure presented a pattern more suggestive of airway disease than of pulmonary emphysema.⁽¹⁵⁾ In the same study, radiographic findings of patients with COPD due to wood smoke exposure did not identify significant emphysema but did show peribronchial infiltrates, bronchial dilatations and atelectasis.

It was shown that the intensity of bronchial hyperresponsiveness was greater in patients with COPD due to wood smoke exposure than in those with COPD due to tobacco smoke exposure, since we obtained, on the bronchoprovocation test, a 20% decrease in FEV₁ with methacholine concentrations of 0.26 and 1.24 mg/mL, respectively. It is therefore inferred that the bronchodilator response index is higher in such patients. In the present study, the response index was significantly lower in the group exposed only to wood smoke. Considering that an increase greater than or equal to 10% in the bronchoprovocation test result was an exclusion criterion in the study, patients with COPD due to wood smoke exposure might have been excluded, and that might have altered the statistical significance.

The intensity of exposure to wood smoke did not correlate with the severity of the obstruction, probably because individual factors related to genetics modulate the effects of exposure, as in COPD due to smoking.

In the data sources used, there was no information on passive smoking, which was not considered a bias, since this factor has not been associated with COPD in population-based studies.^(8,9,19)

Wood combustion causes the production of inorganic oxides, such as carbon monoxide and nitrogen oxide, as well as of particulate matter, polycyclic aromatic hydrocarbons and formaldehyde, all of which are elements proven to be injurious to the respiratory system.⁽²⁰⁾

Among the inhabitants of homes located in rural communities in Bolivia, the particulate matter concentration from biomass burning has been found to correlate with chronic bronchitis.⁽⁶⁾

A population-based study on COPD prevalence, carried out in Colombia,⁽¹⁹⁾ revealed that exposure to wood smoke for more than 10 years is a risk factor for COPD (OR = 2.42), as well as smoking (OR = 2.81). One study⁽⁵⁾ showed that wood smoke exposure greater than 200 hour-years elevates the OR to 15.0 for chronic bronchitis, when comparing women exposed to wood smoke with women not exposed to wood smoke. In Nepal, 12.5% of the cases of chronic bronchitis in nonsmokers were related to domestic pollution due to biomass burning.⁽¹⁷⁾ Another study⁽¹³⁾ showed that women with COPD due to wood smoke exposure presented clinical characteristics, life quality and increased mortality similar to that of women who smoke.

In Brazil, a population-based study carried out in Pelotas⁽⁹⁾ showed that, in spite of the greater OR for COPD in patients exposed to high levels of domestic pollution (OR = 1.86; 95% CI: 1.16–2.99), it was not an independent risk factor in the multivariate analysis. The PLATINO study on COPD prevalence,⁽⁸⁾ carried out in São Paulo, Brazil, also identified no association between wood smoke exposure and COPD. The size of the sample, however, might have been responsible for this lack of correlation. It must be considered that the studies mentioned present methodological differences.

A study in its experimental phase, carried out in rats and dogs submitted to wood smoke exposure, showed bronchitis in all the animals. The same study, in the clinical phase, using biopsy and autopsy

material from women exposed to wood smoke for at least 20 years, revealed bronchitis, anthracosis in the central airways, varying degrees of interstitial fibrosis and few areas of emphysema.⁽²¹⁾

A 2002 publication of the World Health Organization showed that the exposure to smoke due to biomass burning (wood, coal, manure, remains of crop production) for cooking causes the death of 2.5 million people a year in developing countries. This number represents 4 to 5% of deaths that occur yearly worldwide. According to the same publication, the exposure is related to many health problems: acute respiratory infection in children, asthma, chronic bronchitis, lung cancer and diseases which occur during pregnancy.⁽²²⁾ Some studies indicate exposure to wood smoke as a risk factor for tuberculosis.^(23,24) Its association with lung cancer, through pathogenic mechanisms similar to those of tobacco smoke, has also been mentioned.⁽²⁵⁾

In communities in the semiarid area of the Northeast region, as well as in the Amazonian states and the state of Minas Gerais, projects for implementing the use of ecological stoves are being developed. This stove is affordable, uses less wood and causes less environmental pollution. Consequently, its use prevents diseases related to smoke inhalation and decreases the environmental impact of the deforestation for wood and coal production.⁽²⁶⁾ A study carried out in China showed an evident decrease in the COPD risk 10 years after chimneys were added to coal stoves.⁽²⁷⁾

In conclusion, this study described functional and clinical alterations consistent with COPD in patients exposed only to wood smoke for a long period, suggesting that the functional alterations in COPD patients tend to be less pronounced in those exposed only to tobacco smoke. We highlight the need for prospective studies evaluating the prevalence and risk of diseases associated with wood smoke exposure, such as COPD. Finally, we would like to call attention to the need for preventive measures to minimize the effects of this type of exposure.

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