Prevalence of COPD among women and relation with cooking fuel choice in Ouagadougou, Burkina Faso

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SUMMARY

BACKGROUND: According to the WHO, chronic obstructive pulmonary disease (COPD) will become the third leading cause of death by 2030. In sub-Saharan Africa, the burden of the disease is unknown. We assessed the prevalence and the factors associated with COPD and chronic bronchitis among women in charge of household cooking.

METHODS: A cross-sectional population survey was conducted. We randomly selected women aged ≥ 18 years in charge of cooking in their household. COPD was defined as post-bronchodilator FEV₁/FVC (forced expiratory volume in 1 sec/forced vital capacity) ratio of <0.70 ; chronic bronchitis was defined as cough with sputum of at least 3 months in the year for at least 2 consecutive years.

RESULTS: Of the 1705 women interviewed, 835 were selected to perform spirometry and 564 provided an acceptable test result. The prevalence of COPD was 1.1% and that of chronic bronchitis was 1.2%. COPD prevalence was higher among women using biomass, women aged >40 years, those had been cooking or had been exposed to toxic gases for more than 30 years. After adjustment, only biomass fuel use and exposure to toxic products were found to be associated with COPD.

CONCLUSION: Urgent action is needed to accelerate the transition to the other sources of energy.

KEY WORDS: indoor air pollution; biomass fuels; women's health; sub-Saharan Africa

IN SEVERAL LOW AND MIDDLE-INCOME countries, in addition to traditional infectious diseases, non-communicable diseases are becoming increasingly important, in conjunction with socio-cultural changes, escalating urbanisation and unhealthy behavioural and lifestyle patterns.^{1,2} Heart disease, stroke, lung disease and cancers are among the top five causes of death worldwide, and one quarter to one third of these deaths are due to air pollution.³ In 2012, more than 6 million deaths from these diseases were related to air pollution.³

In developing countries, nearly 3 billion people continue to use biomass fuels (wood, agricultural residues, animal dung, charcoal) to satisfy their fuel needs (cooking food, heating water or heating space), leading to the untimely death of about 4.3 million people.⁴ These fuels are often used in unhealthy conditions such as open fires or inefficient fireplaces and poorly ventilated kitchens.⁵ The smoke released contains harmful pollutants, including fine particle matter with diameter of less than 2.5 μm (PM_{2.5}), carbon monoxide (CO) and polycyclic aromatic hydrocarbons (PAHs).^{6,7} In the city of Ouagadougou, Burkina Faso, concentrations of PM_{2.5} produced in

households were found to be higher than the WHO indoor air quality threshold of 25 $\mu\text{g}/\text{m}^3$ per 24 h. The average PM_{2.5} concentrations for 24 h were 110.69 $\mu\text{g}/\text{m}^3$ in outdoor kitchens, 95.69 $\mu\text{g}/\text{m}^3$ in households using traditional stoves and wood, 62.54 $\mu\text{g}/\text{m}^3$ in households using wood and 27.62 $\mu\text{g}/\text{m}^3$ in households using improved stoves and charcoal.^{8,9} As children under 5 years, women and the elderly spend much more time at home or near open fires or cookstoves than others, they are most likely to be affected by indoor air pollution from biomass-based fuel used for cooking.^{10,11}

According to the WHO, 64 million people suffered from chronic obstructive pulmonary disease (COPD) in 2004, including 3 million deaths.¹² By 2030, this disease is expected to become the third leading cause of death in the world.¹² The worldwide prevalence of COPD is growing faster among women than men. Over the past two decades, COPD-related mortality rates have also increased faster in women, and since 2000 more women than men have died from COPD.¹³ Epidemiological studies have shown a strong association between biomass use and COPD occurrence among women.^{14–16} Women exposed to

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biomass smoke are three times more likely to suffer from COPD than those who cook with clean fuels.^{7,17,18}

Although the relationship between COPD and the exposure to biomass smoke from cooking has been largely acknowledged, studies have shown that COPD remains an under-diagnosed pathology. Studies on COPD prevalence in sub-Saharan Africa are extremely scarce. Our study aims to determine the prevalence of COPD among women in charge of cooking in the urban area of Ouagadougou, Burkina Faso, and to examine its association with the main cooking fuel used.

METHODS

Study area and target population

This study is part of a larger research project (IRDC project #107347) focused on the relationship between indoor air pollution and respiratory diseases in Ouagadougou, Burkina Faso, led by Joseph Ki-Zerbo University. The project received the approval of Burkina Faso Ethics Committee for Health Research, Ouagadougou, Burkina Faso (no 2015-9-114).

Between March 2017 and September 2018, a cross-sectional, population-based study was carried out in three neighbourhoods of Ouagadougou: Kilwin, Tampouy and Tanghin. Ouagadougou is the largest city and the capital city of Burkina Faso. The choice of the three sites is explained by their socio-spatial characteristics. All three are residential and fairly representative of the districts of Ouagadougou in terms of socio-economic characteristics and models of space occupation.¹⁹ Eligible participants were women or girls aged at least 18 years, with a minimum of 2 years of residence in the neighbourhood.

Sample size

According to 2012 estimates, the population of Ouagadougou was 1 915 102 inhabitants,²⁰ distributed over 55 neighbourhoods and 12 districts. Using the statcalc tool of Epi Info™ v7.2.2.2 (Centers for Disease Control and Prevention, Atlanta, GA, USA) for calculating sample size for population survey or descriptive study, based on an expected prevalence of 8.5%,²¹ with 2% acceptable margin for error and 95% confidence intervals (CIs), and allowing for a 10% refusal to participate in the study, we estimated that 822 subjects would be required to be recruited in the survey.

However, for the purposes of the project, the sample size was determined and based on the number of cases needed to identify a possible statistical relationship between exposure to pollutants from biomass combustion and COPD. The number of cases needed were therefore calculated using STATA v13.1 (StataCorp, College Station, TX, USA); we then

deducted the number of women to be included in the cross-sectional survey. The parameters used for the calculation at an alpha risk of 5%, power of 80%, odds ratio (OR) of 2 and 95% CI. We assumed the frequency of exposure among controls to be 70%, as 73% of households in the municipality of Ouagadougou used mainly wood or charcoal for cooking.²⁰ Considering two independent populations, the number of cases required was 186. For an average COPD prevalence of 8.5%,²¹ and assuming a non-participation rate of 10%, we found that 2407 participants were required in the cross-sectional survey to obtain 186 cases of COPD. As no sampling frame was available for the neighbourhoods in question, the sampling technique used was the itineraries method.²²

Data collection

The study was conducted in two steps. The first step was to diagnose suspected cases of COPD or asthma by using a symptom-based questionnaire. We selected households and women or girls aged at least 18 years in charge of household cooking with a minimum of 2 years of residence in the neighbourhood. Data on energy choices for cooking, socio-cultural, economic, demographic and personal characteristics of the women participants were collected using a standardised questionnaire. Objective respiratory health data were also collected. Respiratory health information was collected from participants with symptoms of obstructive respiratory diseases such as COPD, including chronic bronchitis (CB) and asthma. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) COPD self-testing questionnaire, "Could It Be COPD?",²³ adapted by the Haute Autorité de Santé (HAS),²⁴ was used in our study for the diagnosis of suspected cases of COPD based on symptoms. This questionnaire is an appropriate tool for COPD screening in the general population.²⁵

The questionnaire used for the medical monitoring of occupational asthma in workers exposed to diisocyanate in Quebec,²⁶ combined with an adapted questionnaire from Venables et al.²⁷ was used for asthma screening in our study population. CB diagnosis was made using the Medical Research Council (MRC) questionnaire.²⁸ Chronic bronchitis has been defined as a sputum cough that lasts at least 3 months in the year for at least 2 consecutive years.¹⁵

On completion of the first stage, suspected cases of COPD, CB and asthma were identified based on symptoms. The second step was to confirm the suspected cases of COPD using spirometry. Those who had positive responses to three of the five questions of the GOLD questionnaire, those with at least three positive responses to asthma screening questionnaire, and those diagnosed with CB were identified as suspected cases.

A portable spirometer, the Spirobank II advanced,

was used. Spirometry was performed seated by trained physicians according to the American Thoracic Society (ATS) criteria.²⁹ The expected values were calculated based on data from the National Health and Nutrition Examination Survey (NHANES III).

At least three measures had to be carried out for each participant and the highest results were considered. If the ratio of forced expiratory volume in the 1 sec (FEV₁) to forced vital capacity (FVC) was >0.70, 200 µg of salbutamol were administered,³⁰ with the consent of the participant. In these cases, post-bronchodilation spirometry was performed at least 10 min after bronchodilator administration. COPD was defined as a post-bronchodilation FEV₁/FVC of <0.70. The results were reviewed by a pulmonologist at the Yalgado Ouedraogo University Hospital.

Data analysis

Data were encoded using EpiData software (EpiData Association, Odense, Denmark). The sample description and analysis were performed using Stata software, v13.0. The dependent variables were COPD and CB. The independent variables analysed were cooking fuel, age, years of cooking, duration of cooking, location of the kitchen in the house, exposition to road traffic pollution, cigarette smoking status (active smoking and passive smoking), occupation (the exercise of any activity, other than cooking, that resulted in exposure to smoke, dust or toxic gases such as pesticide use in gardening, products used in dyeing, soap making, high road sweeping, etc.), burning of mosquito coils, incense burning, previous history of tuberculosis; these variables were selected based on literature review.¹⁶

To be able to correctly interpret the results of the survey, some variables were dichotomised as follows: the main cooking fuel used was dichotomised as biomass vs. liquefied petroleum gas (LPG); number of years of cooking was divided into two groups: 15 years and 30 years, as these were considered significant to develop chronic diseases such as COPD. Participants were divided in terms of age into two groups: ≤40 years and ≥40 years, as some studies shown that COPD is more frequent after 40 years. Kitchens were divided into four categories in terms of location: indoor (kitchen in the main building), outdoor closed (in a separate building), open air (outdoor kitchen with fewer than three walls) and unspecified location. Passive smokers, i.e., those exposed to smoke from other people's cigarettes, cigars or pipes was divided into three groups: those not exposed, those exposed at home or at work and those exposed both at home and at work. Other variables were dichotomised in terms of 'yes' and 'no' categories.

We used conventional statistics to describe the sample. Independent variables were described using frequencies or medians. Prevalence of COPD and CB was estimated and presented as numbers and

percentages. The association between independent variables (including potential confounding factors) and the variables of interest (COPD and CB) was assessed using Pearson's χ^2 test. In case of non-applicability of the χ^2 test (expected <5), Fisher's exact test was used. We performed bivariate analysis to study the associations between each independent variable (the main cooking fuel and potential confounding factors) and COPD, following which multivariate logistic regression was performed. All variables that were associated with a *P* value of <0.2 in bivariate analysis were then considered for inclusion in a multivariable logistic regression model. ORs and their 95% CIs were calculated. *P* < 0.05 was considered significant.

RESULTS

Of the 2407 subjects required, 1735 were finally selected for this study and 1705 participants completed the questionnaire. Among these, 835 met the selection criteria for spirometry. At the end of the study, 564 women had valid test results; 224 participants did not perform the lung function test, either because they refused or they were inaccessible, very busy or had moved or were travelling during the study period; 47 invalid tests were excluded.

In our sample, 59.5% of the women (*n* = 1015) reported the use of biomass-based fuels as their main cooking fuel and 40.48% (*n* = 689) reported using mainly LPG for cooking (Table 1). About 33% of the women interviewed were at least 40 years old, 23% reported cooking indoors and 52% in open air kitchens. Around 46% of the participants reported cooking for more than 2 h a day, 71% for at least 15 years and 28% for at least 30 years. About 36% were exposed to environmental tobacco smoke at home or/and at the workplace.

Using spirometry, we diagnosed 26 cases of airway obstruction, including 12 cases of COPD post-bronchodilation. In terms of conditional probability, it may be inferred that the number of cases of airway obstruction among the women selected for the spirometry and those who did not take part or who completed an invalid test would be 12, with six cases of COPD. The actual prevalence of COPD in our study was 1.1% and the prevalence of airway obstruction was 2.3%.

COPD prevalence was significantly different between biomass fuel users and LPG users, with a higher proportion in former group (Table 2). Among the 12 cases of COPD, 10 were at least 40 years old (1.8%), with a significant difference (*P* < 0.001). CB was diagnosed among 20 participants (1.2% prevalence). Prevalence was significantly higher among women who reported using biomass. However, we did not observe a significant difference in terms of age. No participant with CB was diagnosed with

Table 1 Studied population characteristics

Variables	Categories	Biomass (<i>n</i> = 1015)		LPG (<i>n</i> = 689)		<i>P</i> value*
		<i>n</i>	%	<i>n</i>	%	
Age	≥40 years	391	38.7	179	26.0	<0.001
Cooking place	Indoor	42	4.2	353	51.3	<0.001
	Outdoor closed	242	23.9	155	22.5	
	Open-air	712	70.3	173	25.1	
	Unspecified	17	1.6	8	1.2	
Cooking duration/day	>2 h	468	47.2	321	47.5	0.902
Years of cooking	≥15 years	751	74.7	457	66.9	0.001
	≥30 years	328	32.6	145	21.2	<0.001
Smokers	Yes	0	0	0	0	—
Passive smoking	Yes	386	22.7	233	13.7	0.071

* *P* < 0.05 considered significant.

LPG = liquefied petroleum gas.

COPD during spirometry. The overall prevalence of COPD, including CB was 2.2% (38 cases).

The univariate analysis showed that the combined prevalence of COPD and CB was significantly associated with the type of main cooking fuel used, age, number of years of cooking, the place of cooking meals and other types of exposure to toxic gases. Prevalence was higher among women using biomass, women aged ≥40 years, women who had been cooking for ≥30 years, and those cooking in the open air kitchens (Table 3). In the multivariate analysis, the use of biomass and the exercise of activities that resulted in exposure to other toxic gases were associated with COPD and CB (Table 4).

DISCUSSION

It should be noted that one of the major limitations of the study is the high non-participation rate among the women selected to undergo spirometry. The definition of the exposure variables might also have introduced some ranking bias. Exposure measures of the concentration of indoor air pollutants were not carried out and several women combined two or three types of fuel-like biomass-based fuel, as well as LPG. One of the strengths of this study was the adjustment for numerous confounders. Nevertheless, other parameters that were not included in the analysis may also have impacted the variables of interest.

This study found a low prevalence of COPD (1.1%) and of CB (1.2%) among the study population. This prevalence is consistent with that found by

Mbatchou et al. in the peri-urban area of Bafoussam in Cameroon, who noted a prevalence of around 1.6% for a sample of 300 women aged ≥40 years.³¹ However, the CB prevalence reported in Cameroon was higher (4%) than ours. Other studies conducted in Egypt, Uganda, Mexico and India found prevalences of respectively 6.6%, 16.8%, 2.4% and 2.5%.^{32–35} These frequencies are higher than those observed in our population. One possible explanation for these differences could be related to the characteristics of the selected population such as age (women included in our survey were younger than those included in previous studies), gender composition (studies in Egypt and Uganda included both women and men), smoking status, and frequency, level and duration of exposure. Our study population was randomly constituted of non-smoking women. To note, smoking is not widespread among women in Burkina Faso.

The risk factors identified in our study were the type of main fuel used for cooking, age, numbers of years spent in household cooking, place for preparing meals and the exercise of other activities that lead to exposure to toxic gases. After adjustment, only the type of fuel used for cooking (biofuels) and exposure to other toxic gases remained significantly associated with the disease. In Egypt, Badway et al. observed a difference in COPD prevalence between subjects exposed to biomass smoke and those exposed to non-biomass smoke, with a higher proportion of COPD cases in the group exposed to biomass smoke, *P* < 0.0001.³² Mbatchou et al. did not find a significant association between COPD and the use of wood as fuel for cooking, but between CB and wood use.³¹ Johnson et al. also observed a higher proportion of COPD among biomass users in India; however, this difference was not significant (OR 1.24, 95% CI 0.36–6.64), the difference was also not significant among women who spend more than 2 h on home food cooking.³³ Van Gemert et al. did not find a significant association between the type of fuel used and COPD, but with being a smoker.³⁵

Table 2 Prevalence of COPD and chronic bronchitis in Ouagadougou, Burkina Faso

Variables	Biomass (<i>n</i> = 1015)	LPG (<i>n</i> = 689)	<i>P</i> value*
	<i>n</i> (%)	<i>n</i> (%)	
COPD	12 (1.2)	0 (0)	0.002
Chronic bronchitis	17 (1.7)	3 (0.4)	<0.001

* *P* < 0.05 considered significant.

COPD = chronic obstructive pulmonary disease; LPG = liquefied petroleum gas.

Table 3 Factors associated with COPD and chronic bronchitis in Ouagadougou, Burkina Faso on univariate analysis ($n = 1705$, 1015 biomass users)*

Variables		OR (95% CI)	P value [†]
Main cooking fuel	LPG	1	<0.001
	Biomass	6.74 (2.03–22.33)	
Age, years	<40	1	<0.001
	≥40	3.38 (1.64–6.99)	
Time spent in cooking, years	<15	1	0.30
	≥15	1.61 (0.65–3.97)	
	<30	1	<0.001
	≥30	3.45 (1.66–7.18)	
Place for cooking meals	Indoor	1	0.04
	External closed	4.53 (0.97–21.23)	
	Open-air	4.54 (1.05–19.58)	
	Unspecified	8.19 (0.71–94.91)	
Passive smoking	No	1	0.07
	At home or at work	1.27 (0.58–2.81)	
	At home and at work	2.81 (1.01–7.77)	
Proximity to high traffic road	No	1	0.05
	Yes	0.44 (0.20–1.00)	
Duration of cooking, h	≤2	1	0.08
	>2	1.88 (0.91–3.88)	
Smoke exposure	No	1	0.31
	Yes	1.58 (0.65–3.83)	
Dust exposure	No	1	0.63
	Yes	1.25 (0.49–3.18)	
Exposure to other toxic gases	No	1	0.02
	Yes	3.37 (1.18–9.63)	
Incense burning	No	1	0.48
	Yes	1.28 (0.64–2.59)	
Mosquito spiral burning	No	1	0.25
	Yes	0.66 (0.33–1.34)	
History of tuberculosis	No	1	0.30
	Yes	0.47 (0.11–2.08)	

* Biomass = wood and charcoal.

[†] $P < 0.05$ considered significant.

COPD = chronic obstructive pulmonary disease; OR = odds ratio; CI = confidence interval; LPG = liquefied petroleum gas.

CONCLUSION

The main findings of the study suggest that exposure to biomass smoke causes respiratory damage among women involved in household cooking activity; this is in line with previous studies. Interventions to reduce

the burden of indoor air pollution due to biomass fuel are thus needed. Enhancing women's knowledge and improving behaviours through participative awareness campaigns about the harmful effect of biomass fuel use can be beneficial. The transition to other forms of energy should be accelerated.

Table 4 Factors associated with COPD and chronic bronchitis in Ouagadougou, Burkina Faso on multivariate analysis ($n = 1705$, 1015 biomass users)

Variables		aOR (95% CI)	P value
Main cooking fuel	LPG	1	
	Biomass	4.54 (1.04–19.82)	0.04
Age, years	<40	1	
	≥40	1.12 (0.21–5.84)	0.89
Time spent in cooking, years	<30	1	
	≥30	1.83 (0.35–9.46)	0.47
Place for cooking meals	Internal	1	
	Closed external	1.35 (0.21–8.71)	0.75
	Outdoors	0.77 (0.12–4.74)	0.78
	Other	2.58 (0.18–37.61)	0.49
Passive smoking	No	1	
	At home or at work	0.59 (0.22–1.62)	0.31
	At home and at work	3.17 (0.98–10.22)	0.05
Proximity to high traffic road	No	1	
	Yes	0.84 (0.33–2.14)	0.72
Duration of cooking, h	≤2	1	
	>2	1.56 (0.68–3.58)	
Exposure to other toxic gases	No	1	0.03
	Yes	3.72 (1.16–11.93)	

* Biomass = wood and charcoal.

[†] $P < 0.05$ considered significant.

COPD = chronic obstructive pulmonary disease; aOR = adjusted odds ratio; CI = confidence interval; LPG = liquefied petroleum gas.

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RÉSUMÉ

CADRE : Selon l'OMS, la bronchopneumopathie chronique obstructive (BPCO) deviendra la troisième cause de décès dans le monde en 2030. En Afrique subsaharienne très peu d'études ont analysé le fardeau lié à cette maladie. Cette étude a pour objectif d'estimer la prévalence et les facteurs de risque de la BPCO chez les femmes en charge de la cuisine familiale à Ouagadougou, au Burkina Faso.

MÉTHODE : Une enquête transversale a été conduite dans trois quartiers de la ville d'Ouagadougou de mars 2017 à septembre 2018. L'échantillon était constitué de femmes âgées d'au moins 18 ans, en charge de la cuisine dans leur ménage. La BPCO est définie par un rapport VEMS/CVF (volume expiratoire maximum seconde/capacité vitale forcée) post-bronchodilatation inférieur à 0,70 et la bronchite chronique est définie par une toux chronique avec des expectorations pendant au moins 3 mois de suite dans l'année et au moins 2 années consécutives.

RÉSULTATS : Parmi les 1705 femmes interviewées, 835 répondaient aux critères de sélection pour la spirométrie et 564 femmes ont pu réaliser un test valide. La prévalence de la BPCO confirmée par la spirométrie a été estimée à 1,1% et celle de la bronchite chronique de l'ordre de 1,2%. La prévalence était plus élevée dans le groupe de femmes utilisant de la biomasse comme principal combustible pour la cuisine, les femmes d'âge ≥ 40 ans, celles avec une ancienneté dans la cuisine supérieure à 30 ans, la préparation des repas à l'air libre et l'exercice d'autre activité exposant à des gaz toxiques. Après ajustement, l'utilisation de la biomasse et l'exercice d'autres activités exposant à des produits toxiques restent les facteurs associés à la BPCO.

CONCLUSION : Il est plus qu'urgent de mettre en place des stratégies afin d'accélérer la transition énergétique.

RESUMEN

MARCO DE REFERENCIA: Según la OMS, en el 2030 la enfermedad pulmonar obstructiva crónica (EPOC) se convertirá en la tercera causa de muerte. En África subsahariana se desconoce la carga de morbilidad por EPOC. Se evaluó la prevalencia y los factores asociados con la EPOC y la bronquitis crónica en las mujeres encargadas de cocinar en los hogares.

MÉTODO: Se llevó a cabo una encuesta poblacional transversal. Se escogieron de manera aleatoria mujeres a partir de los 18 años, encargadas de cocinar en sus hogares. Se definió la EPOC como un FEV₁/FVC (flujo espiratorio forzado medio en un segundo/capacidad vital forzada) posbroncodilatador inferior a 0,70 y la bronquitis crónica se definió como la presencia de tos con producción de esputo por lo menos durante 3 meses al año, como mínimo 2 años consecutivos.

RESULTADOS: Se entrevistaron 1705 mujeres, de las cuales se escogieron 835 para realizar la espirometría y se obtuvieron pruebas aceptables en 564 de ellas. La prevalencia de EPOC fue 1,1% y la de bronquitis crónica fue 1,2%. La prevalencia de EPOC fue más alta en las mujeres que utilizaban combustibles de biomasa, las mujeres mayores de 40 años, las que llevaban más de 30 años cocinando y las mujeres que practicaban otras actividades que exponen a gases tóxicos. Tras el ajuste, solo el uso de combustibles de biomasa y la práctica de otras actividades que exponen a productos tóxicos conservaron la asociación con la EPOC.

CONCLUSIÓN: Se precisan medidas urgentes encaminadas a acelerar la transición energética.

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