Indoor air pollution from cooking with biomass fuels is a major cause of chronic bronchitis among women in a rural district of Rwanda

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Abstract

In the developing world, households are using biomass fuel for cooking and heating this leads to high concentration of toxic pollutants indoor causing several respiratory diseases. The aim of this study was to assess the association between biomass fuels and chronic bronchitis among women leaving in a rural district of Rwanda.

Methods: A prospective study was conducted for a period of 15 months between March 2015 and May 2016 and all patients willing to participate were recruited from test villages selected randomly in the district of Gisagara. Obtained data were compared with those from control villages from the distric Huye. 448 women aged 20 years and above were recruited for the study, among them 302 were using biomass fuel for cooking and there was a control group of 146 age-matched women who were using either liquefied gas petroleum or had not been cooking the last 3 years.

Results: Out of 448 women recruited for the study, 12 (2.6%) were excluded for various reasons, among them 298 (68.3%) were using biomass fuel for cooking and 138 (31.7%) belonged to the control group. Using our case definition of chronic bronchitis the overall prevalence was 10.7% of all participants. Chronic bronchitis was significantly associated with cooking indoor (OR: 8.14; 95%, CI 3.45 to 16.84), age (OR: 2.32; 95% CI 1.93 to 3.59) and education level (OR: (OR: 1.66; 95% CI , 0.90 to 3.11).

Conclusion: This study showed that cooking indoor with biomass fuel, age and the level of education are the main risk factors for chronic bronchitis.

In the developing world, households are using biomass fuel for cooking and heating this leads to high concentration of toxic pollutants indoor causing several respiratory diseases including acute respiratory infections, chronic bronchitis, asthma, chronic obstructive pulmonary disease (COPD) and lung cancers.[1,2]

Recently, reports from WHO showed that over seven million deaths every year are caused by air pollution, this makes it one of the most important health risk factor worldwide.[3] Household air pollution is the fourth-leading cause of premature death in the developing world. Indoor air pollution from the burning of solid fuels kills over 1.6 million people, predominately women and children, each year.[4] Exposure to indoor air pollution from the combustion of biomass fuels constitutes a significant public health hazard affecting predominantly poor communities in developing countries.[5] A large number of recent studies have shown that lifestyles and indoor air pollution contribute to the development of allergic diseases and chronic bronchitis,[6] in addition women exposed to heavy indoor smoke are three times exposed to chronic bronchitis compared to those using cleaner fuels.[7,8]

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In Rwanda, most households still resort to the use of wood, charcoal, grass and crop residues for cooking. One third of the households cook in the same house that is used for sleeping.[9] There is an increase in obstructive lung diseases such as chronic bronchitis, unfortunately there is no data on the role of indoor pollution as a cause of chronic bronchitis in the country. This research had focused on women because as in many other developing countries, exposure levels to biomass fuels in Rwanda may be much higher among women who tend to do most of the cooking and among young children who stay indoors and who are often carried on their mother's back or lap while cooking.

The study had provided the prevalence of chronic bronchitis and respiratory symptoms in the studied community, thus solving the problem of lack of data in the country.

The relationship between the exposure to chronic biomass combustion and chronic bronchitis in a rural district of Rwanda was critically studied and obtained data will be useful for health policy makers to set up preventive measures and new strategies for reducing indoor pollution and all resulting health problems.

Material and methods

From March 2015 to May 2016, recruitment of participants was done in the District of Gisagara located in the Southern Province. This district has a total population of 322,506 inhabitants and 98.4% are living in rural area.[10] At the district level, the main source of energy for cooking used by the private households are firewood, charcoal and grass/leaves.

For a period of 15 months, using a multistage stratified sample design, 448 women aged 20 years and above were recruited for the study, among them 302 were using biomass fuel for cooking and there was a control group of 146 age-matched women who were using either liquefied gas petroleum or had not been cooking the last three years. All sectors of Gisagara district were listed (13 sectors in total) and six sectors were randomly selected. From each selected sector, four villages were also randomly chosen and all women aged ≥20 years willing to participate were selected for the study. Following the same procedure, the control group was mainly recruited in the district of Huye (Tumba and Ngoma sectors) more urbanised and located in the direct neighborhood of Gisagara District. Included women were nonsmokers defined as those who had never smoked or

Table 1: Characteristics of respondents

Variables	n	Test village	Control group	%
Age (years)				
20-39	202	144	58	46.4
40-59	132	86	46	30.2
>60	102	68	34	23.4
Respiratory symptoms				
Cough	196	176	20	97
Wheezing	23	16	7	5.3
Shortness of breath	21	18	3	4.8
Nasal symptoms	40	32	8	9.2
Chest pain	30	26	4	6.9
Level of education				
None	86	72	16	19.8
Primary school	220	182	38	50.4
Secondary school	97	39	58	22.2
More than secondary	33	7	26	7.6
Cooking place				
Living room	226	194	32	51.8
Separate kitchen	140	42	98	32.1
Outdoor	70	62	8	16.1

smoked fewer than 100 cigarettes in a lifetime.[11]

This study has been approved by Butare University Teaching Hospital Ethics Committee, all participants were requested to sign a consent form and they underwent a face to face interview on socio demographic status, respiratory symptoms, presence of a kitchen in the household, the type of fuel used for cooking and history of smoking. A short version of the European Community Respiratory Health Survey (ECRHS) questionnaire on chronic bronchitis was used after translation in the local language by a professional translator.

Chronic bronchitis was defined using the commonest definition used in epidemiological studies as the presence of cough and expectoration for at least three months for two consecutive years.[12]

Data analysis was done using the Statistical Package for Social Sciences version 20 (SPSS, Chicago, IL, USA). The Pearson Chi square test was used for tests of independence between the main explanatory variable and other variables. A t test was used for continuous variables. Multivariate logistic regression analysis was conducted to estimate the odds ratio (OR) and 95% confidence interval (CI) of respiratory symptoms and diseases. A two-tailed p value 0.05 was considered as statistically significant.

Results

Out of 448 women recruited for the study, 12 (2.6%) were excluded for various reasons (2 died, 5 did not signed their consent and 5 left the region), we remained with a total of 436 women among them 298 (68.3%) were using biomass fuel for cooking and 138 (31.7%) belonged to the control group. Within the latter, 89 (64.4%) women had not cooked for the last three years and 49 (35.6%) were using gas for cooking. Mean age for both groups was 32.2 years (range 20-83 years). The main respiratory symptoms was cough found in 59.7% of women using biomass fuel and in 14.5% of control cases, wheezes were found in 5.2% of all participants.

Table 2: Factors associated with chronic bronchitis

Factor	OR (95% CI)	P value
Age	2.32 (1.93-3.59)	P<0.001
Level of education	1.66 (0.90-3.11)	P = 0.021
Cooking indoor	8.14 (3.45-16.84)	P < 0.0001
Using firewood	4.14 (2.71-11,18)	P< 0.001

Using our case definition of chronic bronchitis the overall prevalence was 10.7% of all participants. The difference between the test group and the control group in the prevalence of chronic bronchitis was highly significant (p<0.0001).

Regarding respiratory symptoms, our study did not show a significant difference between women who were cooking using firewood and those using charcoal or other types of biomass like grass/leaves and agricultural residues. There was a strong association between chronic bronchitis and using firewood compared to other types of biomass fuel, charcoal was the least biomass fuel associated with the disease (OR, 1.022; 95% CI, 1.13 to 1.29). Among those using biomass fuel, charcoal was used by 12% of participants the majority was using firewood (84%). A separate kitchen was present in 32.1% of households and 51.8% were cooking in the living room whereas 16.1% were cooking outdoor (Table 1).

The majority of women in both groups had been cooking for a period ranging between 5 and 30 years and we noted that the prevalence of chronic bronchitis was higher among women who had been cooking for more than 10 years (13.2%) compared to those who used biomass fuel for a period <10 years (4.2%). The lowest prevalence of chronic bronchitis was found among women who had not cooked for the last three years or never cooked (1.8%). 2.2% of respondents using gas for cooking had chronic bronchitis. We also found a significant association between chronic bronchitis and the level of education, women with the lowest level of education had the highest prevalence of chronic bronchitis (OR: 1.66; 95% CI , 0.90 to 3.11)

There was a strong association between cooking indoor (in the living room or a separate kitchen) with chronic bronchitis. (p<0.001) (Table 2).

Discussion

In developing countries, cooking with biomass fuel as a cause of chronic bronchitis have been reported by many authors but few studies were conducted on the African continent.[13,14,15] The aim of this study was to evaluate the prevalence of chronic bronchitis among women cooking with biomass fuel in the Southern province of Rwanda. To our knowledge this is the first study conducted in the country with a special focus on women. Findings from this research showed a prevalence of 10.7% with

a strong association with firewood and cooking indoor.

This prevalence is almost similar to other studies conducted in Africa, Asia and Latin America,[16,17,18,19] slight differences observed may be linked with many factors including the biomass fuel used, ventilation of the cooking area, cigarette smoking, the house type... In this study, most of houses were built with mud and the roof made of corrugated sheets with a poor ventilation and this may have increased the degree of exposure to toxic smoke.

Cooking indoor was significantly associated with chronic bronchitis, this finding is in agreement with many other authors[20,21,22] who reported that long-term cooking indoor is the most important risk factor for chronic bronchitis. Continuous inhalation of toxic substances from biomass smoke (Particulates matter, CO, hydrocarbons...) leads to a severe irritation of the lung mucosa and defect of the mucociliary system causing respiratory symptoms such as cough and wheezes.[23] In our study many women were cooking in the living room, houses were poorly ventilated and few had a chimney.

Aging was associated with Chronic bronchitis, further analysis showed that the prevalence of chronic bronchitis among women aged >30 years was less than 4.5% compared to 13.2% for those aged ≥30 years. Tasleem Ahkatar et al.[24] in India had observed an increasing of chronic bronchitis with increasing age. This shows that the duration of exposure to biomass fuels plays an important role in the development of chronic bronchitis, long-term exposure to toxins negatively affect the mucociliary system of the lung resulting in chronic airways inflammation.[23] In this study, for practical reasons, we used questionnaires with a face to face approach to maximise the response rate, limitations are that we did not monitor the daily time for cooking and we did not measure the level of indoor pollution using appropriate devices.

Majority of respondents in this study were using firewood for cooking simply because charcoal is expensive compared to other biomass fuels. Charcoal does not produce smoke this explains why it is preferred over wood for cooking in many parts of the world. Wood burning produces lot of smoke and tend to release products of incomplete combustion, also known as particulates, that are harmful to humans when inhaled.[25]

The level of education was associated with chronic bronchitis, there is no clear explanation for this finding, however we can speculate that women with a higher level of education may be more informed about the danger of cooking indoor thus taking protective measures. This finding is different to the study conducted in Nigeria by Umoh V. et al[26] who found that education attainment did not play a significant role in chronic bronchitis and argued that majority of participants had less than six years of formal education. In our study majority of subjects in the control group had completed secondary school and few had a university degree.

This is the first study conducted exclusively among women in Rwanda, however our sample size does not allow generalisation of our findings at the national level, further studies with larger samples are needed to complete our findings.

In conclusion, this study shows that cooking indoor with biomass fuel, age and the level of education are the main risk factors for chronic bronchitis.

Acknowledgment

We thank the University of Rwanda for funding this research and all the population of Gisagara District for the immense cooperation.

Author declaration

Competing interests: none.
Any ethical considerations involving humans or animals: none.
Was informed consent required? No.

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