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## Chronic Bronchitis in Women Using Solid Biomass Fuel in Rural Peshawar, Pakistan\*

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**Background:** Biomass smoke has been associated with many diseases. The aim of this study was to evaluate the relationship between biomass smoke and chronic bronchitis in women in the rural setting of Peshawar, Pakistan.

**Methods:** Three villages in rural Peshawar were randomly selected as “test villages” where biomass fuel was used. The women responsible for cooking in these villages were interviewed for the prevalence of bronchitis, and data were compared to those obtained from three matching “control villages” where liquid petroleum gas was used as fuel. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using a statistical software package (EPI Info, version 6.0 [public domain software]; Centers for Disease Control and Prevention; Atlanta, GA).

**Results:** This study was carried out in 1,426 female test patients and 1,131 female control subjects. Chronic bronchitis was found in 100 women (7.01%) in the test group and 33 women (2.92%) in the control group. The OR was 2.51 (95% CI, 1.65 to 3.83). A strong association was found between bronchitis and the use of wood (OR, 2.38; 95% CI, 2.12 to 3.01), dung cake (OR, 2.01; 95% CI, 1.72 to 2.42), rice straws (OR, 3.32; 95% CI, 1.11 to 9.88), and kai grass (OR, 1.96; 95% CI, 1.75 to 2.45). Cooking in the living room and bronchitis were highly associated (OR, 2.5; 95% CI, 1.94 to 3.66). An association between the presence of a kitchen and bronchitis was established with an OR of 2.65 (95% CI, 2.10 to 3.42). In the test group, 75% of kitchens were ventilated; in the control group, 82% were ventilated. The difference between the two groups was nonsignificant ( $p > 0.6$ ;  $\chi^2 = 0.39$ ; OR, 0.83; 95% CI, 0.5 to 1.4).

**Conclusions:** Biomass fuel exposure is strongly associated with chronic bronchitis in women who are involved in cooking in rural Peshawar. (CHEST 2007; 132:1472–1475)

**Key words:** biomass fuel; bronchitis; indoor pollution

**Abbreviations:** CI = confidence interval; OR = odds ratio

Biomass fuel is composed mainly of wood, animal dung, and crop residue. About 50% of the world population and 90% of rural communities in developing countries are using biomass as a single source of cooking fuel.<sup>1</sup>

Different studies have reported biomass smoke as a cause of acute upper and lower respiratory infection,<sup>2,3</sup> otitis media,<sup>4</sup> chronic bronchitis/obstructive airway diseases,<sup>5–8</sup> lung cancer,<sup>9</sup> asthma, pulmonary tuberculosis,<sup>10</sup> low-birth-weight babies,<sup>11</sup> cataracts,<sup>12</sup> and mouth/nasopharyngeal carcinoma.<sup>13</sup> These effects are attributed to respiratory irritants like oxides of carbon, nitrogen, and sulfur, and to unburned hydrocarbon particles and

polycyclic organic compounds, including carcinogens such as benzo [ $\alpha$ ]-pyrene.<sup>14</sup>

In Pakistan, the majority of households in rural communities use biomass fuel for cooking and space

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heating. The type of fuel used has an important role in health and disease. This role gains further significance when cooking is done in the living room, which is a common practice in winter. This survey was conducted in three villages around Peshawar, where purified fuel is still not available and the families are exclusively using solid biomass fuel for

cooking food. An attempt has been made to test the hypothesis that there is a close association/relationship between the use of biomass fuel and chronic bronchitis in women who are responsible for cooking through a comparison with a control group from rural areas around Peshawar.

## MATERIALS AND METHODS

The study was conducted in three villages around Peshawar, Pakistan, from September 2003 to June 2004. The villages were selected by using a multistage stratified sampling design to obtain a representative sample. Test and control villages having comparable geographic locations, populations, and socioeconomic status were randomly selected because they respectively used biomass fuel and liquid petroleum gas exclusively. A total of 20% of the households were randomly selected and included in the study. Approval for the study was taken from the Institutional Ethical Review Committee of Khyber Medical College Peshawar. Female nonsmokers who were responsible for cooking in the family were interviewed after informed consent was given. All relevant information (*ie*, age, socioeconomic status, family size, marital status, presence of a kitchen, and type of fuel used by the household) were recorded. Age at marriage and period/time spent daily for cooking were also recorded.

Chronic bronchitis was defined using the criteria of the American Thoracic Society,<sup>15</sup> which state that bronchitis is a condition with chronic or recurrent excessive mucous secretion into the bronchial tree occurring on most days for the last 3 months of the year for at least 2 successive years. The effect of cooking smoke on the prevalence of bronchitis was determined. The results are presented in the form of odds ratios (ORs) with 95% confidence intervals (CIs), and were compared through the  $\chi^2$  test for the association of different parameters in the two groups. For statistical analysis, a statistical software package (EPI-Info, version 6.0) was used.

## RESULTS

A total of 2,557 women (test villages, 1,426 women; control villages, 1,131 women) were interviewed and investigated during this study. Different characteristics of the two groups are presented in Table 1.

A total of 93% of households in the rural test areas used solid biomass fuels for cooking, which included wood, kai grass, dung cake, bagasse, and wood saw

dust. In control villages, liquid petroleum gas was used by 97% of households.

Chronic bronchitis was prevalent in 100 women (7.01%) in the test group and 33 women (2.92%) in the control group. The OR was 2.51 (95% CI, 1.65 to 3.83). The difference in the two groups was highly significant, with a Mantel-Haenszel  $\chi^2$  value of 21.44 and  $p < 0.0001$ . Chronic bronchitis increased with increases in the ages of the respondents in both groups. In the test group, chronic bronchitis was more prevalent (89%) in women  $> 30$  years of age compared to those  $< 30$  years of age.

A strong association was found between bronchitis in the respondents and the use of wood (OR, 2.38; 95% CI, 2.12 to 3.01), dung cake (OR, 2.01; 95% CI, 1.72 to 2.42), rice straws (OR, 3.32; 95% CI, 1.11 to 9.88), and kai grass (OR, 1.96; 95% CI, 1.75 to 2.45) in the test villages. The Student *t* test results were highly significant, with  $p < 0.0001$  for all four of the categories of fuel used.

A total of 363 of the households (25.45%) in the test villages and 413 of the households (36.51%) in the control villages cooked in the living room. The mean period of cooking in both the test and control villages was 4 months per year. It was noted that 0.55% of respondents in the test villages and 5.84% of respondents in the control villages were used to cooking in the living room for 12 months. The difference in the two groups was highly significant ( $p < 0.0001$ ;  $\chi^2 = 41.5$ ; OR, 2.5; 95% CI, 1.94 to 3.66).

A kitchen was present in 41.6% of households in the test villages and 54.7% of households in the control villages. An association between the presence of a kitchen and bronchitis in respondents from test villages vs those from control villages was established with an OR of 2.65 (95% CI, 2.10 to 3.42) and a  $\chi^2$  value of 68.2. The difference in the two groups was highly significant ( $p < 0.0001$ ).

In the test villages, a U-shaped stove was used in 79.7% of households, a triangularly shaped stove made of bricks was used in 15.9% of households, and a metallic angithi was used for burning wood saw dust in only 4.4% households. The difference between the two types of stoves (*ie*, U-shaped and triangularly shaped) for the history of bronchitis was nonsignificant ( $p > 0.56$ ;  $\chi = 0.28$ ; OR, 0.90).

The maximum period of cooking in 92% of respondents from test villages and 87% of respondents from control villages was up to 30 years. The majority of respondents in test villages (44%) and control villages (37%) had cooked in the kitchen for the last 11 to 20 years. The prevalence of bronchitis in women females who had cooked for a period  $< 10$  years was 27.5%, compared to 72.5% among women who had cooked food for  $> 10$  years.

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**Table 1 —Comparison of Population Characteristics in Test and Control Villages\***

Characteristics	Test Villages	Control Villages	p Value
Population	34,118	40,800	
Households visited	1,141	867	
Gender			
Male	6,183 (50.8)	4,978 (50.9)	
Female	6,000 (49.2)	4,796 (49.1)	
Male/female ratio	1:1.04	1:1.04	
Mean family size	8.57 ± 4.070	8.41 ± 4.071	> 0.73
Monthly income, Pakistani rupees			
< 5,000	1,157 (81.19)	725 (64.22)	< 0.001
5,000–10,000	220 (15.44)	303 (26.83)	< 0.001
> 10,000	48 (03.36)	101 (08.95)	< 0.001
Women interviewed	1,426	1,131	
Married	1,178 (82.8)	898 (79.4)	
Unmarried	242 (17.0)	214 (18.9)	
Widows	06 (0.4)	19 (1.7)	
Children	4.98 ± 2.57	4.74 ± 2.56	> 0.70
Live	4.82 ± 2.47	4.61 ± 2.43	< 0.006
Still birth	0.17 ± 0.70	0.13 ± 0.55	> 0.66
< 5 yr old	1.59 ± 0.66	1.57 ± 0.55	> 0.46
Age distribution, %			
10–20 yr	16.3	14.4	
21–30 yr	40.5	39.5	
31–40 yr	28.6	28.8	
41–50 yr	10.3	12.8	
51–60 yr	2.6	04.1	
> 60 yr	1.8	0.01	
Mean age, yr	30.96 ± 10.65	31.66 ± 10.33	> 0.73
Mean age at marriage, yr	16.5 ± 2.82	17.5 ± 3.58	> 0.49

\*Values are given as No. (%) or mean ± SD, unless otherwise indicated.

A total of 91% of women in the test group and 93% of women in the control group responded that they spend up to 4 h a day cooking. Bronchitis was prevalent in 20.8% of women who spent < 2 h per day cooking in the kitchen compared to 79.2% of women who spent > 2 h per day cooking in the kitchen.

The association between bronchitis and family size was almost the same for both the test and control groups. The frequencies of bronchitis with a family size of less than four members were 10.7% and 13.2%, respectively, in the test and control groups compared to 89.3% and 86.8%, respectively, in two groups with family sizes of greater than four members.

It was observed that with a family income of < 5,000 Pakistani rupees per month, the frequency of bronchitis in women was 81.9% and 63.5%, respectively, in test and control respondents compared to 18.1% and 36.5%, respectively, for the two groups with family incomes of > 5,000 Pakistani rupees per month. The difference was highly significant ( $p < 0.0001$ ;  $\chi^2 = 51.34$ ) [ $\$1$  (US) = approximately 60 Pakistani rupees].

## DISCUSSION

In developing countries, the indoor air pollution from biomass smoke is the most direct physical

health risk, in both adults and children.<sup>16</sup> The association of exposure to biomass smoke with chronic bronchitis is quite well established, particularly among women.<sup>17</sup>

Chronic bronchitis in nonsmoking women has been reported<sup>18</sup> to vary from 0.44 to 4.96% by different investigators from India. According to the findings of this study, chronic bronchitis was more prevalent in women from test villages with an increasing trend in age. Although the results from this study are fairly high compared to those reported from India, they are consistent with those reported by the National Health Survey of Pakistan,<sup>19</sup> revealing that the prevalence of chronic bronchitis increases with an increase in age. Among women 15 to 24 years of age, the prevalence is < 2%. Over the age of 65 years, prevalence increases to 14% among rural women, endorsing the results of earlier reports<sup>20</sup> in female subjects from Gujjar, a rural area in the Kashmir valley. Studies from Nepal<sup>21,22</sup> and Turkey<sup>23</sup> have also yielded similar statistics showing that domestic smoke pollution, particularly due to biomass fuel, is a contributing factor in the prevalence of chronic bronchitis in rural women.

In our study, 85% of women were at an active child-bearing age, which, according to a policy point of view, is very important. In the literature,<sup>11</sup> many

problems related to pregnancy, such as stillbirth and low birth weight, are linked with exposure to pollutants from biofuels. The survey revealed that after 40 years of age the involvement women as chief cook is reduced to only 15%. This could be due to the fact that daughters or daughters-in-law take over the responsibility of cooking in the family. Similar results have been reported in a study from India,<sup>24</sup> where approximately 70% of women involved in cooking are in the age group 16 to 20 years.

Cooking with traditional methods without proper ventilation has adverse impacts on human health. According to a study from rural Rajasthan, India,<sup>25</sup> even a partition between the kitchen and the living space can greatly reduce the health hazards of indoor air pollution. It is evident also from this study that those women who were cooking in living rooms had a high prevalence of chronic bronchitis. The duration of cooking (in years) and the daily time spent cooking (in hours) have a significant impact on the prevalence of chronic bronchitis and are significantly higher among those women who had spent > 2 h cooking for a period > 10 years. Low income and large family size have significant influence on cough and phlegm.

The results of this study indicate that the inadequate supply of clean fuels in rural areas contributes to the hardship, ill health, and economic loss of its population. Therefore, the coordinated, consistent, and focused cooperation of all stakeholders at the grassroots, policy-making, and implementation levels is needed for these areas of the country. An attempt should also be made to address the suffering of women, and a proper treatment strategy be evolved for this female population.

Biomass fuel is a primary fuel source in rural areas of Pakistan, and a large proportion of the population is exposed to its smoke, while health effects are not documented in literature. Therefore, this research would add to the existing knowledge on the topic.

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