Clinical Profile and Pulmonary Function Tests among Females Exposed to Household Fuel Smoke in Bhavnagar, Gujarat: A Cross-Sectional Study

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ARTICLE INFO

Original Article

Received: 15 Dec 2020

Accepted: 28 Apr 2021

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ABSTRACT

Background: Studies from developing countries, suggest that exposure to smoke from household fuels like wood, animal dung, and kerosene used for domestic cooking, may be a risk factor for airway diseases among women. This study aims to find the effect of household fuel smoke among them through clinical profile and pulmonary function test.

Methods: A cross-sectional study was conducted in respiratory medicine outpatient department of Sir T Hospital in Government Medical College, Bhavnagar. Female participants were interviewed with pretested semi-structured questionnaires. They included respiratory symptoms, housing condition, kitchen environment, type of household fuels, habits and history of passive smoking, the number of hours per day and the number of years spent for cooking (biomass exposure index). Chest x-ray and pulmonary function tests like spirometry and diffusion capacity of lungs were performed. Through purposive sampling, 100 female participants were included in the study, and data were analyzed using SPSS version 17.0 versions and Chi-square test.

Results: The total number of participants was 100 with a mean age of 46.89±12. Three out of 10 had a history of passive smoking. Most of the patients suffered from dyspnea (84%) and cough (76%) as the main symptoms. Nearly half (43%) of them had a runny nose. 30% were passive smokers and 70% were nonsmokers. The patients' cough and expectoration had a significant association with forced expiratory volume (FEV1)/ Forced Vital Capacity (FVC) > 70 (P=0.02). The study suggested that with aging, the odds for Fev1/FVC becoming <70 (OR: 4.24; 95% CI: 1.14-15.72, p=0.03) goes higher. The patients who had a history of exposure to smoking had higher odds of having FEV1/FVC<70 (OR: 4.000; CI: 1.4851 to 10.7739, p=0.006).

Conclusion: The findings suggest that clinical symptoms like dyspnea and cough are significant when there is exposure to household fuels like kerosene, animal dung and wood usage. Smoke emitted from such fuels play an important role in deterioration of lung functions. Efforts should be made to create awareness regarding household fuel smoke effect on health and reduction of their use.

Keywords: Household Fuel Smoke Exposure, Kaccha House, Pakka House, Biomass Exposure Index, Pulmonary Function Test

How to cite this paper:
Patel B, Dave J, Mehta J, Engti R, Gohel K, Kalkotar S, et al. Clinical Profile and Pulmonary Function Tests among Females Exposed to Household Fuel Smoke in Bhavnagar, Gujarat: A Cross-Sectional Study. J Community Health Research 2023; 12(1): 1-6.

Introduction

Cooking is the art and science of using heat to prepare food for consumption. Phylogenetic analysis suggests that our ancestors may have invented cooking as far as 1.8 million to 2.3 million years ago(1). The controlled use of fire by Homo erectus which began some 400,000 years ago has been widely supported by academics (2,3). Therefore, different household fuels are used all over the world. Many countries use solid fuels such as coal and biomass i.e. wood, cow dung, herb residues, liquid fuels like kerosene and the newer ones. In recent decades, gaseous fuels like petroleum gas and natural gas are also used. Exposure to smoke from cooking fires causes 3.8 million premature deaths each year, mostly in low- and middle-income countries. They consist of burning fuels such dung, wood and coal in inefficient stoves or open hearths producing a variety of health-damaging pollutants. They include particulate matter (PM), methane, carbon monoxide, polyromantic hydrocarbons (PAH) and volatile organic compounds (VOC) and household air pollution (HAP).(4,5)In developing countries like India, domestic cooking is a daily function of Indian women. They start cooking at the age of around 15 and spend approximately more than one hour per day for 30 to 40 years of their lives equivalent to 60,000 hours.(6) Housing conditions also play a significant role in indoor air pollution like ventilation of kitchen in house, having or not having a separate kitchen or the housing materials like the house wall and roof made up of mud, straw wood stones and dry leaves called as “Kachcha home” in India. This is while bricks, iron roads and cement are called “Pakka Home”. Balakrishanan et al. studied the quantified exposures to respirable PM from biomass-fuel (BIF) combustion in Indian rural homes.(7) It showed that personal exposures to respirable PM during cooking using BIF was significantly higher for those using clean fuel and put emphasis on the above mentioned factors.

Studies both in India and other countries confirmed that exposure to household fuel smokes had a significant association with chronic respiratory symptoms such as chronic cough, sputum production and respiratory diseases such as chronic bronchitis, asthma, chronic obstructive pulmonary disease (COPD). It also causes tuberculosis among women, deteriorates lung functions and increases mortality as well as morbidity, which directly and indirectly affects the health of accompanying children (8–10). The present study was conducted to investigate the effect of household fuel smoke for the women exposed in terms of clinical features. It was done with regard to housing condition “kachcha” or “pakka”, its open or closed ventilation, history of exposure to active or passive smoking, radiological changes and lung functions tested by spirometry.

Methods

A cross sectional study was done among 100 female participants with 30 to 80 years of age, a history of exposure to household fuel smoke in terms of Biomass exposure index (9,11), ability to perform pulmonary function test, and willingness to provide voluntary written informed consent for attending the study's outpatient department (OPD) were included in the study using purposive sampling after ethical committee approval . Participants with pre-existing respiratory and cardiac diseases, having past history of tuberculosis, inability to perform pulmonary function test, addiction to smoking, and those who did not provide a consent form were excluded from the study.

Subjects were interviewed by researchers. Data were collected for clinical, socioeconomic and demographic parameters, type of household fuel, the number of hours spent for cooking using these household fuels for biomass exposure index (9,11), the type of house like “kachcha” or “Pakka”, using open or close ventilation in kitchen and respiratory symptoms. Data was collected using pretested, semi structured questionnaires. Plain chest x-ray and pulmonary function tests (forced vital capacity maneuver) were performed to find respiratory abnormalities. Pulmonary function tests were done using pneumotech based Med Graphics Elite DL pulmonary diagnosis system (Medical Graphics Corporation, U.S.A). All the tests were performed according to American Thoracic Society/European Respiratory Society guidelines in sitting position regarding the body temperature, pressure, and water vapor saturated correction (12). FVC, forced expiratory volume in one second (FEV1), FEV1/FVC ratio, and forced expiratory flow (FEF) during 25-75% of FVC (FEF 25-75%) parameters were recorded.

Data analysis

Data were analyzed through SPSS software version 17.0. The results were provided in mean ± standard deviation for all the continuous variables and in frequency (percentage) for categorical variables. Statistical analysis was done with Chi-square test to find differences regarding proportions. $P< 0.05$ was considered statistically significant.

Biomass exposure index

Biomass exposure index was introduced to compare the clinical and functional parameters of participants regarding the time exposed to household fuel smoke while cooking. The index expressed the number of hours spent per day and the number of years of biomass exposure (9,11).

Results

Table 1 shows the socio-demographic details of the study participants. Their mean age was 46.89±12. There was almost the same rural – urban distribution of the participants. 86% had a separate kitchen. Three out of 10 had a history of passive smoking.

Most of the patients (63%) were in 31–50 age groups. The elderly patients (>60) constituted 12% of the population.

Most of the patients suffered from dyspnea (84%) and cough (76%) as the chief symptoms, and nearly half of the patients (43%) had a runny nose.

The average number of people living together in houses with 100 women participants was 11.5. There were 30% passive smokers and 70% nonsmokers.

Table 1. Demographic details of the study participants

Distribution of the patients regarding age	
Age group	**Number (n)**
21-30	4
31-40	33
41-50	31
51-60	20
61-70	8
71-80	4
Exposure details regarding biofuels	
Kerosene	21
Animal dung	50
Wood	90
Mixed	65
Distribution regarding symptoms	
Dyspnea	84
Cough	76
Fever	8
Chest pain	23
Runny nose	43
Seasonal variation	21
Housing details	
Urban	51
Rural	49
Kachcha house	61
Pakka house	39
Open ventilation	46
Closed ventilation	54
Having a separate kitchen	86
Not having a separate Kitchen	14

Table 2. The association of cough with expectoration and FEV1/FVC

	FEV1/FVC<70	FEV1/FVC>70	Total	P value
Cough with expectoration	15	20	35	0.02
Cough without expectoration	27	12	39	
Total	42	32	74	

This table 2 demonstrates that patients' cough and expectoration had a significant association with FEV1/FVC>70 at p=0.02. This may be due to the presence of more middle-aged patients.

This table 3 demonstrates that the age of over 65 had significant association with FEV1/FVC >70. As the age increases, there is a higher chance of FEV1/FVC becoming <70 (**OR: 4.24; 95% CI: 1.14-15.72, p=0.03**).

There is a significant association between exposure to smoking and FEV1/FVC. The patients who had a positive history of being exposed to smoking had higher odds of having FEV1/FVC<70 (**OR: 4.000; CI: 1.4851 to 10.7739, P=0.006**).

Table 3. Bivariate analysis of the distribution of patients regarding FEV1/FVC and age group

Age	FEV1/FVC<70	FEV1/FVC>70	Total	P value
<65	26	63	89	0.02
>65	7	4	11	
Total	33	67	100	

Table 4. History of passive smoking

Smoking	FEV1/FVC<70	FEV1/FVC>70	Total	P value
In contact with active smoker	12	18	30	0.004
Lack of contact with active smoker	10	60	70	
Total	22	78	100	

Table 5. Testing the Association between exposure index of various BIFs and FEV1/FVC

Biomass exposure index	<60	>60	Total	P value
Wood	17	70	87	0.51
Mixed	5	33	38	
Kerosene	10	42	52	
Animal dung	13	37	50	

Table 5 indicates that there is no significant relationship between the type of BIFs used and the airflow limitation in a patient. Thus, all BIFs have similar potency for airflow obstruction.

Discussion

In this study patients were suffering from symptoms of dyspnea (84%), cough (39%), cough with expectoration (35%), runny nose (43%) with or without seasonal variation rather than fever (8%) and chest pain (23%). Behra et al. (11) studied 3701 women using various types of household fuels including BIF, solid one and LPG with a history of active or passive smoking. They found that dyspnea and post-nasal drip were the most common symptoms among the mix of fuel user, and chronic bronchitis in chula users were significantly higher than Liquified Petroleum Gas (LPG) and kerosene. In this study 65% participants were using mixed type of fuels.

The results suggested that household fuel smoke plays a significant role in causing deterioration of lung functions in terms of abnormal pulmonary function tests and clinically affecting physical health clinically causing cough. In a study conducted in India, the respiratory symptoms such as wheezing, dyspnea, chronic cough, and nocturnal cough were significantly more common in the group using BMF than LPG users. A significant difference was observed in the lung function indices between the two groups. A significant negative correlation between respiratory indices and duration of exposure and the PM values suggested a greater decline of lung function among women exposed to increased concentrations of PM (13). The authors also observed a lower lung function in participants exposed to BMF. Exposure to air pollutants causes constriction of the airway smooth muscles and irritation of the mucous glands, leading to wheezing, and overproduction of sputum. Biomass smoke contains a combination of gases and PM which are known to weaken host defenses. (14)

A decline in the spirometric parameters occurs with age and is accelerated in patients with pulmonary disease (15,16). In this study, the age of over 65 had a significant association with FEV1/FVC <70. This table also denotes that with aging, there will be higher odds of FEV1/FVC becoming < 70 (OR: 4.24; 95% CI: 1.14-15.72, p = 0.03).

Among passive smokers, lung functions were found to have a more significant obstruction than nonsmokers using household fuel for cooking in this study. Out of 34, 6 participants suffered from a mild COPD, 19, a moderate COPD, and 9 had severe COPD according to global initiative for obstructive lung disease (GOLD) (17). In a study by Bajpai et al., (18) out of 360 COPD cases, about 2/3rd (60%) were smokers and the rest were nonsmokers. Overall, males were predominant (57.2%); but, there was a higher number of female patients in the nonsmoker group (25% vs. 70%; P = 0.001). Among the 144 nonsmoker COPD patients, the most important and statistically significant risk factor was exposure to biomass smoke (68.06%)

Biomass exposure index of 60 and above was considered to be high risk for developing COPD. It was studied as the threshold value of exposure index by P. A. Mahesh et al. in Mysore district of India (9). The study by Garg A. et al. revealed that out of 140 cases, 131 had obstructive lung functions (11, mild, 49, moderate, 39, severe, and 32 experienced a very severe obstruction). They also found that cumulative exposure index (CEI) was directly proportional to the severity of obstructive lung disease, stating that CEI can be used as a primary tool to quantify the exposure (5). In this study, most of the participants having the exposure threshold of less than 60 experienced respiratory complaints and impairment in lung function. Few studies discussed the threshold value for exposure index as a predictive marker for assessment of the effect of BIF smoke effect on health. More studies are required to find such threshold value.

Bill Brashier et al.'s study focused on the high resolution computed tomography thorax (HRCT) and lung function differences between the BIF smoke exposure induced COPD and tobacco smoking (TS) COPD. (19) Biomass smoke-induced COPD subjects showed lower lung volumes and less mean % emphysema than TS COPD on HRCT imaging. In this study, only 8 participants with x-ray chest showed COPD.

One of the limitations of this study was not including a sex-age matching population as control (unexposed individuals). This is because all the symptomatic patients had visited a tertiary care center, and people who used liquefied petroleum gas or natural gas exposure as a single fuel did not visit the outpatient department for any respiratory complaint. All females were exposed to multiple fuels. Therefore, the comparison among different fuels was not possible, which limits the scope of analysis. Efforts should be made regarding raising awareness and reduction in the use of traditional household fuels to prevent various respiratory diseases.

Conclusion

Clinical symptoms like dyspnea and cough are common problems regarding the exposure to household fuels like kerosene, animal dung and wood. The smoke emitted from such fuels play an important role in deterioration of lung functions. Efforts should be made to create awareness with regard to household fuel smoke's effect on health and reduce its use. India has recently identified HAP as one of the key indicators in its national monitoring framework for prevention and control of non-communicable diseases (NCD). This provides an excellent opportunity to advocate the reduction of adverse effects due to household BIF use.

Acknowledgement

The authors would like to thank Dr. Pradip Pithadia, the Assistant professor of department of community medicine at Government Medical College, Jamnagar, for reviewing comments and Dr Kinjal Rami, Assistant Professor in Department of Respiratory Medicine, Government Medical College, and Jamnagar.

Conflict of interest

The authors declared no conflict of interest.

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