

Original Research Article

The association between different types of cooking fuels and common health problems: north India region

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ABSTRACT

Background: The fuel used for cooking is a major source of indoor air pollution because of inefficient combustion and inadequate ventilation. This study was conducted to see if there is any association between the type of cooking fuel and common health problems in light of inadequate ventilation.

Methods: This was a cross-sectional study; 688 subjects were selected randomly from various sectors and the outlying areas of Surajkund. The impact of indoor air pollution on health was assessed by questionnaires, general physical examination, and pulmonary function testing.

Results: One of the key findings of the study has been the implication of LPG, touted as a safe, non-polluting fuel with a definite negative impact on health. There was significantly more breathlessness experienced by LPG users as opposed to the users of wood and cow dung. Though the prevalence of fever in both groups was similar, chest pain, burning of eyes, and fatigue were reported by wood and cow dung users much more frequently. The pulmonary function test showed restrictive pathology in cow dung and wood users, whereas obstructive pathology in LPG users.

Conclusions: LPG is considered “clean” fuel because it does not produce visible emissions. However, improper burner design, blocking and clogging of the flue vent, and insufficient combustion air result in improper combustion and the emission of aldehydes, CO, hydrocarbons, and other organics. It would be folly to believe that LPG is harmless. Even a harmless material may become harmful if used inappropriately.

Keywords: Biomass, Health impact, Indoor air pollution, LPG, Pulmonary function test

INTRODUCTION

Fuel used for cooking is a major source of indoor air pollution in developing countries like India. In 2000, a study reported that 58.5% of people were using firewood in rural areas and 22.5% were using it in urban areas; Similarly, 18% of people in rural and 4% of people in urban areas were using cow dung cake; LPG was used by 4% people in rural areas and close to 42% in urban areas.¹

The indoor air pollution caused by the pollutants released by the burning of these fuels, especially in poorly ventilated settings, is responsible for many deleterious effects on human health. It results in nearly 2 million premature deaths per year, of which 44% are due to pneumonia, 54% due to chronic obstructive pulmonary disease (COPD), and the remaining 2% due to lung cancer.²⁻⁴ Women and young children are most severely affected as they are the ones who spend maximum time at

home.⁵⁻⁷ The pollutants released by the combustion of cooking fuel can cause a variety of problems.⁸ The particulate matter gets lodged in the medium-sized airways and causes respiratory infections, chronic bronchitis, COPD, TB, and may also lead to exacerbation of these conditions.⁹ Sulfur dioxide and nitrogen dioxide can potentially cause wheezing and exacerbation of asthma. Sulfur dioxide is also implicated in the exacerbation of COPD and cardiovascular diseases.¹⁰ Carbon monoxide, on the other hand, increases the risk of poor perinatal outcomes like low birth weight and perinatal death. Biomass smoke, especially metal ions and polycyclic aromatics are harmful to the eyes and lead to the early development of cataract. Polycyclic aromatic hydrocarbons increase the risk of developing cancers of the lungs, mouth, nasopharynx, and larynx.¹⁰

The cooking fuel used and its impact on human health due to the emissions are to a great extent determined by the state of ventilation i.e., cooking in closed space or open space.¹¹

So, the main objectives of the study were, (1) to analyse the impact when cooking takes place in a closed space or in an open space, (2) to see if there is any association between the type of cooking fuel used and common health problems, especially in women as they are at a greater risk because of their exposure to these fuels while cooking, and (3) to determine if clean fuels like LPG are safe, particularly in view of inadequate ventilation.

METHODS

A cross-sectional study was conducted in Faridabad, the 9th biggest industrial town in India, with a total population of 21,94,581 (11,93,063 males and 10,01,523 females) in 2001, covering an area of 2151 km². The study was conducted for a period of three years. A convenient sampling technique was used to randomly select 688 subjects from various sectors and the outlying areas of Surajkund, a town in Faridabad. Pretested semi-structured questionnaire was used for collecting information regarding demographic characteristics, socioeconomic characteristics, type of cooking fuel used, and health problems like burning of eyes, breathlessness, fever, etc. Further assessment was performed by general physical examination and pulmonary function testing. The researchers conducted direct interviews with all survey respondents within the local communities in their native language.

The data collected was organized into tables and the chi-square test was applied to find out if there was any significant association between the type of cooking fuel used and the common health problems. We also tried to find out a correlation between the place of cooking and the type of fuel used, and if the place of cooking contributed to the health problems caused by cooking fuels.

RESULTS

Demographic overview

A total of 688 subjects were surveyed. Characteristics of the study population were presented in Table 1. 55.3% of the participants were male. 55% of the participants had 10 years of formal education. 37% of the participants were of low socioeconomic status and only 13% were of higher socioeconomic status whose income was above 1,00,000 per month (According to Kuppuswami classification). 12.2% of participants were active smokers. Almost 40 percent of the study population was young, i.e., between 20-40 years of age. There were fewer children less than 10 years of age. Similarly, there were fewer old subjects above 60 years.

Table 1: Demographic overview of study population.

	Frequency	%
Gender distribution		
Male	367	55.3
Female	321	46.7
Total	688	100.0
Age wise distribution in years		
<10	73	10.6
11-20	114	16.6
21-30	148	21.5
31-40	140	20.4
41-50	76	11.0
51-60	57	8.3
>60	80	11.6
Type of cooking fuel used		
Electric heater	17	2.5
LPG	550	79.3
Kerosene	5	0.7
Coal	4	0.6
Cow dung and wood	102	16.2
Not answered	5	0.7
Distribution according to educational status		
Primary	240	34.9
Matriculation	139	20.2
Intermediate	89	12.9
Bachelors	124	18.0
Masters	70	10.2
PhDs	4	0.6
Not answered	22	5.2
Smoking habits		
Current	84	12.2
Former	38	5.5
Never	547	79.2
Not answered	19	2.9

The different types of fuels used by the study population were electric heater, LPG, kerosene, coal, cow dung cake and wood. Majority of the population under study used LPG for cooking (80%) and 16.20% individuals were using cow dung and wood.

Table 2: Association between type of cooking fuel used and common health problems.

Type of fuel used	Common health problems (% of diseased subjects)				
	Breathlessness	Chest pain	Burning of eyes	Fatigue	Fever
Electric Heater	52.9	0	82.3	70.5	76.4
LPG	23.8	15.8	39.8	32.9	24.3
Kerosene	0	0	40	0	20
Coal	0	75	100	100	50
Cow dung cake; wood	19.6	23.2	53.8	49	26.4

Breathlessness and type of fuel used

Out of 688 study individuals, 25.3% (160) reported breathlessness. A maximum percentage of breathlessness was seen in electric heater users (52.9%), followed by LPG users (23.8%) and cow dung cake and wood users (19.6%) (Table 2).

A maximum percentage of breathlessness was found in electric heater users, likely because the heat released from the heaters makes the air dry, which accentuates the effect of fuel emissions. The 2nd highest percentage was found amongst LPG users, most likely because of cooking in closed spaces. Fuels like kerosene, coal, cow dung and wood don't seem as harmful because the cooking takes place in the open.

Chest pain and type of fuel used

Out of a total of 688 individuals, 115(16.7%) subjects reported chest pain. A maximum percentage of chest pain was found in people using coal as a cooking fuel (75%), followed by Cow dung cake and wood users (23.2%) (p value <0.05) (Table 2).

The findings are intuitive as the emissions of gases like carbon monoxide from these fuels are known to cause hypoxia by decreasing the oxygen-carrying capacity of hemoglobin. The heart has to work harder to compensate for the tissue hypoxia resulting in chest pain.

Burning of eyes and type of fuel used

Out of 688 subjects, 299 (45.5%) subjects reported burning of the eyes. The maximum percentage of burning of the eyes was found in coal users (100%), followed by users of electric heaters (82.3%) and cow dung cake and wood (53.8%) (p value <0.05) (Table 2).

All the subjects using coal as fuel had burning eyes, likely because of the particulate matter and fumes released upon its combustion which irritate the cornea. The high percentage of electric heater users can be explained by the dehydrating effect of the heat emitted, which makes the cornea dry and causes a burning sensation.

Fatigue due to type of fuel used

Out of 688 subjects studied, 247 (35.9%) reported fatigue. A maximum percentage of fatigue was found in subjects using coal as a cooking fuel (100%), followed by electric heater users (70.5%) and users of cow dung cake and wood (49%) (p value <0.05) (Table 2).

All coal users are seen to be experiencing fatigue. This can be attributed not only to the carbon monoxide emissions which cause hypoxia but also to the difficulties in procuring coal every day for cooking purposes which in itself is a tiring task. The same goes for cow dung and wood. As for electric heaters, fatigue can be attributed to the dehydration caused by the heat.

Fever and type of cooking fuel

25.7% of subjects were having fever out of a total study population of 688. A maximum percentage of fever was found in users of electric heaters (76.4%), followed by coal users (50%) (p value <0.05) (Table 2).

As can be intuitively expected, electric heater users were reported suffering from fever the most. The subjective feeling of raised body temperature might be because of the increased heat they were constantly experiencing.

Type of fuel used for cooking and pulmonary function test (PFT)

34.3% of individuals were found to have a restrictive pattern of PFT, maximum in case of users of coal (50%), followed by users of cow dung cake and wood (38.2%). 9.3% of individuals were found to have an obstructive pattern of PFT, maximum in the case of users of cow dung cake and wood (38.2%), followed by users of coal (25%) (p value <0.05) (Table 3).

The restrictive pattern was more common than the obstructive pattern overall. As we all know, particulate matter is known for causing interstitial lung diseases (restrictive pathology), by causing chronic inflammation and fibrosis. The obstructive pattern seen in a few subjects was likely because of airway hyperresponsiveness to emissions released by fuel combustion.

Table 3: The association between type of cooking fuel used and pulmonary function test.

Type of fuel used	Pulmonary function test			% of users with restrictive PFT	% of users with obstructive PFT
	Restrictive	Obstructive	Total		
Electric heater	4	1	17	23.5	5.8
LPG	190	53	550	34.5	9.6
Kerosene	1	0	5	20	0
Coal	2	1	4	50	25
Cow dung cake; wood	39	39	102	38.2	38.2
Total	236 (34.3%)	64 (9.3%)	688 (100%)		

Table 4: Correlation between disease profile and place of cooking.

Type of fuel used	Place of cooking			% cooking in open place	% cooking in closed place
	Open place	Closed place	Total		
Electric heater	9	8	17	52.9	47%
LPG	126	422	550	23	76.7
Kerosene	3	2	5	60	40
Coal	3	1	4	75	25
Cow dung cake; wood	14	1	102	13.7	0.9
Total	155 (22.5%)	434 (63.1%)	688 (100%)		

Correlation between disease profile and place of cooking

22.5% were cooking in an open place and 63.1% cooked in a closed place.

23% of LPG users were using it in the open whereas the majority (76%) was using it in closed space for cooking. The LPG while undergoing combustion releases nitrogen dioxide and carbon monoxide gas and these can be particularly harmful in closed spaces especially if ventilation is inadequate (Table 4).

33% of subjects suffering from chest pain and fever were cooking in a closed place, and 22% of chest pain cases were reported in people who were cooking in an open place. Similarly, in case of breathlessness, the majority of cases occurred in people cooking in closed spaces (30%), as compared to those cooking in open spaces (23%).

Therefore, we can conclude that the place of cooking and quality of ventilation also impact the health of individuals in addition to the type of cooking fuel used.

DISCUSSION

One of the key findings of the study has been the implication of LPG and electric heaters touted as safe non-polluting fuels with a definite negative impact on health. There was significantly more breathlessness experienced by an electric heater and LPG users as opposed to the users of wood and cow dung. As for the users of electric heaters, the possible explanation may be

that heaters remove water vapour and moisture from the air we breathe and make the air dry. This results in the irritation of the airways and may be the cause of breathlessness resulting from the irritation initiated by dry air. We don't know if those experiencing this effect had any pre-existing illness which may have made them prone to the effect of emissions from LPG combustion, particularly carbon monoxide. If that is the case, housewives and those who use LPG for cooking must be warned that in case they have ischemic heart disease, which is becoming common these days, exposure to the combustion products of LPG may trigger an angina attack.

According to the 2001 Census of India, 36.7% of Indian households used LPG as cooking fuel. 76.64% of such households were from urban India as compared to a usage of only 5.7% in rural Indian households. Our results are in agreement with the census data that despite a low socio-economic status over-representation in the sample, less than a quarter was using cow dung and wood and a majority (79%) were using LPG, regarded as a superior fuel.

According to the World Health Report 2002, half the world's population is exposed to indoor air pollution, mainly the result of burning solid fuels for cooking and heating.¹² Globally, it is estimated to cause 36% of all lower respiratory infections and 22% of COPD.³ The cooking fuel use and its impact on human health due to emissions are to a great extent determined by the state of ventilation.¹¹ It was no surprise to find that 94% of people using cow dung and wood were doing so in an open area whereas the majority of LPG users were using it in a

closed space, which means home kitchens. One has to note that most middle-class homes have a small kitchen with poor ventilation. It is in these poorly ventilated kitchens that an average Indian middle-class homemaker spends a considerable part of her day and life. She is therefore exposed to the toxic gases that improper combustion of LPG causes.

LPG is considered “clean” fuel because it does not produce visible emissions. However, gaseous pollutants such as nitrogen oxides, carbon monoxide, and organic compounds are produced as are small amounts of sulfur dioxide and particulate matter.¹³ The most significant factors affecting these emissions are burner design, burner adjustment, boiler operating parameters, and flue gas venting. Improper design, blocking and clogging of the flue vent, and insufficient combustion air result in improper combustion and the emission of aldehydes, carbon monoxide, hydrocarbons, and other organics.¹⁴ Nitrogen oxide emissions are a function of several variables, including temperature, excess air, fuel, air mixing, and residence time in the combustion zone. The amount of sulfur dioxide emitted is directly proportional to the amount of sulfur in the fuel. Particulate matter emissions are very low and result from soot, aerosols formed by condensable emitted species, or boiler scale dislodged during combustion. In our assessment, the excess breathlessness due to LPG use may be due to carbon monoxide release. There is an urgent need to create awareness about using LPG in a closed space with improper ventilation which may be a serious health risk. The other points raised about the burner design, burner adjustment, boiler operating parameters, flue gas venting, improper design, blocking and clogging of the flue vent, and insufficient combustion air may be understood by the users. Previous studies have reported the health risk when LPG is used in poorly ventilated kitchens like in middle-class homes.^{15,16} It would be folly to believe that LPG is harmless. Even a harmless material may become harmful if used inappropriately.

Though the prevalence of fever in both groups was similar, chest pain, burning of eyes, and fatigue were reported by wood and cow dung users much more frequently. This is not surprising as the main emissions from wood and cow dung burning consist of PM and other health-damaging pollutants such as carbon monoxide, sulfur oxides, nitrogen oxides, aldehydes, benzene, and polyaromatic compounds.^{10,17} These pollutants mainly affect the lungs by causing inflammation, reduced ciliary clearance, and impaired immune response. Systemic effects also result, for example, in reduced oxygen-carrying capacity of the blood because of carbon monoxide, which may be a cause of intrauterine growth retardation.¹⁸ Evidence is emerging, thus far only from developed countries, of the effects of particulates on cardiovascular disease. When we compared the pulmonary functions of the two groups (FVC, FEV₁, FEV₁%) we found somewhat more restrictive lung pathology in those using cow dung and

wood than the LPG users but less of obstructive pathology which was somewhat more in LPG users. The differences were, however, not significant. Many other authors have found evidence of poor pulmonary functions in biomass fuel users like cow dung and wood.^{19,20} We believe that the reason we did not find such deterioration in lung function in biomass fuel users was that cooking was taking place in the open.

CONCLUSION

The two common fuels used for cooking were LPG and Cow dung and wood. It was heartening to find that even though the bulk of study subjects belonged to low socioeconomic status, they were using LPG, regarded to be a safer fuel. The prevalence of breathlessness was reported to be higher in individuals using electric heaters and LPG, which we would interpret as the result of exposure to oxides of nitrogen and carbon monoxide released when LPG undergoes combustion, especially in settings of poor ventilation. Though the overall morbidity was more due to the use of wood and cow dung, there are issues of ventilation and certain other points which must be considered when using LPG to avoid harm to health. There is a need to create awareness about the safe and proper use of LPG to prevent harm, especially in those using small unventilated kitchens where an average Indian housewife spends most of her time. This should be understood that there is nothing that causes no harm. Only right and proper use prevents harm.

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REFERENCES

1. Viswanathan B, Kumar KK. Cooking fuel use patterns in India: 1983-2000. *Energy Polic*. 2005;33(8):1021-36.
2. Dherani M, Pope D, Mascarenhas M, Smith KR, Weber M, Bruce N. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. *Bull World Health Organ*. 2008;86(5):390-8.
3. Kurmi OP, Semple S, Simkhada P, Cairns W, Smith S, Ayres JG, et al. COPD and chronic bronchitis risk of indoor air pollution from solid fuel: a systematic review and meta-analysis. *Thorax*. 2010;65:221-8.
4. Sapkota A, Gajalakshmi V, Jetly DH, Roychowdhury S, Dikshit RP, Brennan P, et al. Indoor air pollution from solid fuels and risk of hypopharyngeal/laryngeal and lung cancers: a multicentric case-control study from India. *Int J Epidemiol*. 2008;37(2):321-8.
5. Bhat RY, Manjunath N, Sanjay D, Dhanya Y. Association of indoor air pollution with acute lower

- respiratory tract infections in children under 5 years of age. *Paediatr Int Child Health*. 2012;32(3):132-5.
6. Mishra V. Effect of indoor air pollution from biomass combustion on prevalence of asthma in the elderly. *Environ Health Perspect*. 2003;111(1).
 7. Johnson P, Balakrishnan K, Ramaswamy P, Ghosh S, Sadhasivam M, Abirami O, et al. Prevalence of chronic obstructive pulmonary disease in rural women of Tamil Nadu: implications for refining disease burden assessments attributable to household biomass combustion. *Glob Health Act*. 2011;4(1):7226.
 8. Bruce N, Perez-Padilla R, Albalak R. Indoor air pollution in developing countries: a major environmental and public health challenge. *Bull World Health Organ*. 2000;78(9):1078-92.
 9. Mishra VK, Retherford RD, Smith KR. Biomass cooking fuels and prevalence of tuberculosis in India. *Int J Infect Dis*. 1999;3(3):119-29.
 10. Behera D, Balamugesh T. Indoor air pollution as a risk factor for lung cancer in women. *J Assoc Phys India*. 2005;53:190-2.
 11. Norboo T, Yahya M, Bruce NG, Heady JA, Ball KP. Domestic pollution and respiratory illness in a Himalayan village. *Int J Epidemiol*. 1991;20(3):749-57.
 12. World Health Organization. The world health report 2002: reducing risks, promoting healthy life. World Health Organization; 2002. Available from: https://apps.who.int/iris/bitstream/handle/10665/42510/WHO_2002.pdf. Accessed on 2 September 2021.
 13. USEPA. AP42 1.5 Liquefied Petroleum Gas Combustion, update July 2008. Available from: https://www.epa.gov/sites/default/files/2020-09/documents/1.5_liquefied_petroleum_gas_combustion.pdf. Accessed on 2 September 2021.
 14. Behera D, Dash S, Malik SK. Blood carboxyhaemoglobin levels following acute exposure to smoke of biomass fuel. *Indian J Med Res*. 1988;88:522-4.
 15. Deepthi Y, Nagendra SS, Gummadi SN. Characteristics of indoor air pollution and estimation of respiratory dosage under varied fuel-type and kitchen-type in the rural areas of Telangana state in India. *Sci Tot Environ*. 2019;650:616-25.
 16. Kandpal JB, Maheshwari RC, Kandpal TC. Indoor air pollution from domestic cookstoves using coal kerosene and LPG. Indian Institute of Technology Delhi; 1995.
 17. Naeher LP, Brauer M, Lipsett M, Zelikoff JT, Simpson CD, Koenig JQ, et al. Woodsmoke Health Effects: A Review. *Inhal Toxicol*. 2007;19(1):67-106.
 18. Boy E, Bruce N, Delgado H. Birth weight and exposure to kitchen wood smoke during pregnancy in rural Guatemala. *Environ Health Perspect*. 2002;110(1):109-14.
 19. Alim MA, Sarker MAB, Selim S, Karim MR, Yoshida Y, Hamajima N. Respiratory involvements among women exposed to the smoke of traditional biomass fuel and gas fuel in a district of Bangladesh. *Environ Health Prev Med*. 2014;19(2):126-34.
 20. Saha A, Mohan Rao N, Kulkarni P, Majumdar P, Saiyed H. Pulmonary function and fuel use: a population survey. *Respir Res*. 2005;6(1):127.

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