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Indoor air pollution from solid fuels and risk of hypopharyngeal/laryngeal and lung cancers: a multicentric case–control study from India

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Background A recent monograph by the International Agency for Research on Cancer (IARC) has identified indoor air pollution from coal usage as a known human carcinogen, while that from biomass as a probable human carcinogen. Although as much as 74% of the Indian population relies on solid fuels for cooking, very little information is available on cancer risk associated with these fuels in India.

Methods Using data from a multicentric case–control study of 799 lung and 1062 hypopharyngeal/laryngeal cancer cases, and 718 controls, we investigated indoor air pollution from various solid fuels as risk factors for these cancers in India.

Results Compared with never users, individuals who always used coal had an increased risk of lung cancer [odds ratio (OR) 3.76, 95% confidence interval (CI) 1.64–8.63]. Long duration of coal usage (>50 years) was a risk factor for hypopharyngeal (OR 3.47, CI 0.95–12.69) and laryngeal (OR 3.65, CI 1.11–11.93) cancers. An increased risk of hypopharyngeal cancer was observed among lifelong users of wood (OR 1.62, CI 1.14–2.32), however this was less apparent among never-smokers. Increasing level of smokiness inside the home was associated with an increasing risk of hypopharyngeal and lung cancer ($P_{trend} < 0.05$).

Conclusion This study showed differential risks associated with indoor air pollution from wood and coal burning, and provides novel evidence on cancer risks associated with solid fuel usage in India. Our findings suggest that reducing indoor air pollution from solid fuels may contribute to prevention of these cancers in India, in addition to tobacco and alcohol control programs.

Keywords Lung cancer, laryngeal cancer, hypopharyngeal cancer, indoor air pollution, solid fuels

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Introduction

Indoor air pollution resulting from the use of solid fuels (wood, crop residue, animal dung, coal) for cooking and heating is a significant public health concern in developing countries where a substantial proportion of the population relies exclusively on such fuels for cooking and heating. In these areas, it has been estimated that indoor air pollution resulting from the combustion of solid fuels may be one of the leading contributors to the global burden of disease, among environmental risk factors.[1] In India, where as much as 74% of the total population uses solid fuels for cooking,[2] it has been estimated that indoor air pollution may account for up to 4–6% of the national burden of disease.[3] The majority of solid fuels used in India are either wood, crop residue or cow dung cake, accounting for 70.7%, 13.5% and 13.1% of total solid fuels used, while coal, lignite and charcoal combined together account for less than 3%.[2]

A recent monograph on indoor air pollution by the International Agency for Research on Cancer (IARC) concluded that indoor air pollution from coal usage is a known human carcinogen, while that from biomass (primarily wood) is a probable human carcinogen.[4,5] However, the expert committee acknowledged that the majority of studies that linked indoor air pollution from coal with increased risk of lung cancer were from certain areas of China (Xunwei County) characterized by poorly ventilated dwellings.[6–10] The committee further pointed out that the limited studies that did exist outside of China often combined all solid fuels together, which made it difficult to independently evaluate different types of solid fuels. One such study reported an increased risk of lung cancer associated with the use of solid fuels (coal and wood) in Central and Eastern European populations.[11] Similarly, use of solid fuels (wood or charcoal) in early childhood was associated with an increased risk of lung cancer in Taiwan.[12] In contrast, the independent effect of exposure to wood smoke on risk of lung cancer is less clear, with fewer studies showing positive associations.[13,14] Others have reported exposure to wood smoke as a risk factor for oral cancer,[15] nasopharyngeal cancer[16] and cancers of the upper aero-digestive tract[17] in China and Brazil.

Despite the high prevalence of solid fuel usage, only a limited number of studies have explored the relationship between indoor air pollution from solid fuel and the risk of cancer in India. These studies have provided conflicting results; one study found no significant risk associated with either wood or coal usage and the risk of lung cancer,[18] while a smaller study reported a highly significant risk of lung cancer associated with the use of solid fuels (wood, cow-dung cake, agricultural waste and coal) for cooking.[19] Moreover, no studies to date, have investigated indoor air pollution as a risk factor for hypopharyngeal/laryngeal cancers in India, where the incidence of these cancers is among the highest in the world.[20–22] Using data from a multicentric case–control study conducted in India, this study aimed to estimate the risk of lung, hypopharyngeal and laryngeal cancer for individuals who use coal or wood compared with those who use modern fuels for cooking.

Methods

A multicentric case–control study was conducted in India between 2001 and 2004. The four participating centres were the Gujarat Cancer and Research Institute in Ahmedabad, the Gandhi Medical College in Bhopal, the Chittaranjan National Cancer Institute in Calcutta and the Cancer Institute (WIA) in Chennai. Details regarding the study methods have been published elsewhere.[23] Altogether, 1062 incident hypopharyngeal/laryngeal cancer cases (ICDO-2 codes C-12, C-13, C-14, C-32), and 799 incident lung cancer cases (ICDO-2 code C-34) were recruited. Controls ($N = 718$) who were frequency-matched to cases on age (±5 years), sex and geographical area of residence were recruited from a population of individuals hospitalized for diseases unrelated to tobacco or alcohol consumption (19%) or visitors to hospital patients whose diseases were unrelated to tobacco or alcohol (81%). Additional enrollment criteria for both cases and controls included residence in the predefined study area for at least 1 year and age less than 80 years. No single disease/condition made up more than 25% of the control group [health checkup: 24%; treatment of gastritis: 9%; blood donor 8%; neoplasm of rectum 8%; treatment of thyroid 6%; fracture/musculoskeletal 5%; unspecified neoplasm of breast: 5% and other smaller categories(<5%) combined 35%]. A standardized questionnaire was administered to all study participants by trained staff members. To avoid interviewer bias, each interviewer interviewed equal numbers of cases and controls, in parallel in all centres. These interviewers collected data on demographic and socioeconomic status, clinical history, family history of cancer, tobacco and alcohol consumption habits, dietary factors, occupation, residential history and type of fuel used in each residence. Study participants were also asked to summarize the overall level of smokiness inside the home for each residence period as: (i) none, cooking usually done outdoors, (ii) none, cooking done indoors but little smoke, (iii) some smokiness caused by cooking, (iv) much smokiness caused by cooking but not enough to irritate eyes and (v) smokiness caused by cooking enough to irritate eyes. Cumulative years of fuel usage were calculated based on the number of years spent in each residency and the type of fuel used during that period.

Of the 1062 laryngeal/hypopharyngeal cases, nine were excluded because they lacked information on histology and diagnosis method. An additional 11 cases were excluded because they were diagnosed with squamous cell carcinoma *in situ*. Of the 1042 eligible cases, 953 (91.5%) were diagnosed by histology or cytology and 943 were squamous cell carcinoma. Similarly, of the 799 lung cancer cases, four were excluded because they had a missing histology. An additional two cases were excluded because they were diagnosed with carcinoma *in situ*. Altogether, 80% of the lung cancer cases were diagnosed by histology or cytology with the remaining 20% diagnosed clinically/ X-ray. Of the 635 lung cancer cases with histological/ cytological verification, 263 were adenocarcinoma and 219 were squamous cell carcinoma.

Ever-smokers were defined as individuals who smoked at least 50 cigarettes over a 6-month period, while ever-chewers and drinkers were defined as those who chewed tobacco products or drank alcohol at least once a week for a minimum of 6 months. Product specific smoking durations were obtained by using the age at which individuals started and stopped smoking the specific tobacco products (bidi, cigarette, cigar/cheroot). Cumulative tobacco smoking was calculated after assigning a cigarette-equivalent value of 0.5, 1 and 2 for each unit of bidi, cigarette and cigar/ cheroot,[24–26] and multiplying the number of cigarette-equivalent by the years of smoking. A variable to indicate socio-economic status (SES) was created by combining the scores given to level of education, monthly family income and index of crowdedness (number of people per room, calculated by dividing the family size by number of rooms in the house).

Statistical analysis

Statistical analyses were performed using STATA, version 8 (Stata, College Station, TX). Odds ratios (ORs) and the corresponding 95% confidence intervals (CIs) for each risk factor under consideration were estimated using unconditional logistic regression models after adjusting for age, sex, participating centre, SES as a categorical variable and cumulative tobacco smoking as a continuous variable. Analyses for hypopharyngeal/laryngeal cancers were additionally adjusted for years of alcohol consumption and chewing tobacco products. Tests for linear trends were performed by treating the categorical variables as continuous predictors in the logistic regression models. For investigating cancer risks based on the type of fuel used, lifetime users of gas, electricity and kerosene were combined into a single group (modern fuel) and used as a reference group. Individuals who always cooked outdoor were excluded from the analysis investigating risk associated with level of smokiness inside homes, as they represented the lowest SES class. We conducted analysis with and without the clinically diagnosed cases. However, the analysis restricted to only the histologically or cytologically confirmed cases did not show material changes with respect to the results of the analysis that also included the clinically diagnosed cases. Therefore, we report the results from the analysis that included all cases.

Results

The majority of participants in the study were men as shown in Table 1. The case groups with a lower proportion of women were laryngeal cancer (6.5%) and squamous cell carcinoma of the lung (9.6%), whereas the case groups with higher proportions of women included hypopharyngeal cancer (16.2%) and lung adenocarcinoma (17.5%). Overall, a higher proportion of controls were of higher SES compared with cases, while higher proportions of cases were smokers.

Compared with lifelong users of modern fuel, a slight increased risk of hypopharyngeal cancer (Table 2) was observed among those who were ever users of solid fuels (OR 1.34, 95% CI 0.97–1.86). No increased risk among ever users of solid fuels was observed for laryngeal cancer or lung cancer. When the ever users of solid fuels were subdivided based on the propensity of usage (less than 1/2 of lifetime, more than 1/2 of lifetime and always), those who always used solid fuels had an increased risk of hypopharyngeal cancer (OR 1.62, CI 1.14–2.32).

When ever users of solid fuels were divided according to specific fuel types, an increased risk of hypopharyngeal cancer was observed among those who always used wood (OR 1.56, CI 1.09–2.25), with no evidence of an increased risk for laryngeal or lung cancer (Table 2). However, when this analysis was restricted among never-smokers, the increase in risk of hypopharyngeal cancer was only apparent among those who used wood for less than their entire lifetime (OR 1.67, CI 0.79–3.52), but not for lifetime users (OR 1.11, CI 0.63–1.98). Individuals who always used coal had an increased risk of lung cancer (OR 3.76, CI 1.64–8.63), and a borderline increased risk of laryngeal cancer (OR 2.42, CI 0.94–6.25). When the analysis was restricted to never-smokers, an increased risk of lung cancer (OR 7.46, CI 2.15–25.94) was observed among those who always used coal.

Long duration (>50 years) of coal usage was a risk factor for all types of cancer considered (Table 3), with a duration-dependent increase in risk observed for hypopharyngeal cancer ($P_{trend} = 0.06$), laryngeal cancer ($P_{trend} = 0.05$) and lung cancer ($P_{trend} < 0.01$). A similar duration-dependent increase in risk was observed for hypopharyngeal cancer and wood usage ($P_{trend} = 0.03$), however no such risk was observed for lung or laryngeal cancer and wood usage. Table 4 presents the ORs for self-reported measures of pollution level inside homes. An increasing risk was observed for increasing level of smokiness for hypopharyngeal cancer ($P_{trend} < 0.02$), and lung cancer overall ($P_{trend} < 0.01$).

Discussion

Indoor air pollution from coal burning is a known human carcinogen (IARC group 1), while that from biomass (primarily wood burning) is a probable

Table 1 Demographic characteristics of the study population

	Controls		Hypopharynx		Larynx		Lung	
	N	%	*N*	%	*N*	%	*N*	%
Centre								
Ahmedabad	203	28.3	222	43.3	213	41.7	193	24.3
Bhopal	73	10.2	21	4.1	47	9.2	72	9.1
Calcutta	110	15.3	117	22.8	119	23.3	267	33.7
Chennai	332	46.2	153	29.8	132	25.8	261	32.9
Sex								
Male	607	84.5	430	83.8	478	93.5	694	87.5
Female	111	15.5	83	16.2	33	6.5	99	12.5
Age								
1 (⩽34)	76	10.6	20	3.9	24	4.7	16	2.0
2 (35–44)	156	21.7	54	10.5	32	6.3	67	8.4
3 (45–54)	230	32.0	158	30.8	134	26.2	212	26.7
4 (55–64)	182	25.3	163	31.8	187	36.6	264	33.3
5 (65–74)	68	9.5	91	17.7	106	20.7	201	25.3
6 (⩾75)	6	0.8	27	5.3	28	5.5	33	4.2
SES category								
1 (Low)	60	8.4	128	25.3	97	19.6	120	15.5
2 (Low medium)	195	27.2	232	45.9	209	42.2	301	38.8
3 (High medium)	216	30.1	107	21.2	131	26.5	207	26.7
4 (High)	247	34.4	38	7.5	58	11.7	148	19.1
Smoking								
Never	457	63.6	149	29.0	97	19.0	177	22.3
Former	52	7.2	64	12.5	76	14.9	120	15.1
Current	209	29.1	300	58.5	338	66.1	496	62.5
Chewing tobacco Prd								
Never	585	81.5	379	73.9	413	81.0	669	84.4
Ever	133	18.5	134	26.1	97	19.0	124	15.6
Drinking								
Never	580	80.8	393	76.8	371	72.7	608	76.7
Ever	138	19.2	119	23.2	139	27.3	184	23.2

human carcinogen (IARC group 2A).[4,5] It contains many hazardous pollutants including known human carcinogens such as benzo(a)pyrene, formaldehyde and benzene.[5] Exposure to such indoor air pollution is a major public health concern in India because the majority of its population still relies on solid fuels for cooking.[2]

In this study, an increased risk of hypopharyngeal cancer was observed among ever users of solid fuels. Detailed analyses showed that wood usage is a risk factor for hypopharyngeal cancer, but not for laryngeal cancer or lung cancer. The increased risk of hypopharyngeal cancer was also supported by an analysis based on the duration of usage (Table 3) which showed increasing risk associated with increasing duration of wood usage ($P_{trend} = 0.03$). However, in the analysis restricted to non-smokers, the increased risk of hypopharyngeal cancer associated with wood usage was less apparent. Therefore, this particular finding must be cautiously interpreted as residual confounding from smoking cannot be ruled out at this point. However, the findings of increased risk for hypopharyngeal cancer are consistent with a study conducted in Brazil[17] that reported an increased risk of pharyngeal cancer associated with the use of wood stoves. Similar findings were also reported in a study conducted in Germany, but the fuel types in the German study were mixed types; therefore, a direct comparison is difficult to make.[27,28]

In contrast, an increased risk was observed for all types of cancers considered in the highest exposure group of lifetime coal users, with the highest risk

Table 2 Odds ratios by cooking fuel types

	Count	Hypopharynx[a,b]			Larynx[a,b]			Lung[a]		
		N	OR	95% CI	*N*	OR	95% CI	*N*	OR	95% CI
All Individuals										
Always modern[c]	344	118	1.00		150	1.00		275	1.00	
Ever solid	372	395	1.34	(0.97–1.86)	358	0.95	(0.69–1.31)	509	0.98	(0.74–1.31)
Lifetime fuel usage										
<1/2 solid	65	18	0.47	(0.24–0.93)	24	0.46	(0.25–0.87)	29	0.41	(0.23–0.74)
>1/2 solid	56	51	1.38	(0.80–2.36)	51	0.89	(0.52–1.55)	55	0.90	(0.54–1.51)
Always solid	251	326	1.62	(1.14–2.32)	282	1.14	(0.80–1.62)	425	1.21	(0.88–1.65)
Type of solid fuels										
>1/2 wood	43	49	1.64	(0.93–2.90)	45	0.95	(0.52–1.72)	49	1.11	(0.64–1.92)
Always wood	237	305	1.56	(1.09–2.25)	257	1.06	(0.74–1.53)	381	1.06	(0.77–1.47)
>1/2 coal	13	2	0.38	(0.08–1.91)	5	0.65	(0.19–2.17)	7	0.35	(0.11–1.14)
Always coal	10	12	1.92	(0.67–5.54)	18	2.42	(0.94–6.25)	35	3.76	(1.64–8.63)
Mixed/other	69	27	0.66	(0.36–1.19)	33	0.53	(0.30–0.95)	38	0.49	(0.28–0.84)
Never-smokers										
Always modern[c]	210	37	1.00		38	1.00		75	1.00	
Ever solid	245	112	1.11	(0.67–1.85)	58	0.63	(0.37–1.07)	101	0.84	(0.55–1.29)
Lifetime fuel usage										
<1/2 solid	44	7	0.57	(0.21–1.56)	2	0.20	(0.04–0.87)	9	0.47	(0.20–1.13)
>1/2 solid	42	20	1.67	(0.79–3.52)	10	0.94	(0.27–1.55)	14	0.94	(0.44–2.02)
Always solid	159	85	1.11	(0.63–1.98)	46	0.79	(0.43–1.44)	78	0.95	(0.59–1.54)
Type of solid fuels										
>1/2 wood	33	18	1.91	(0.87–4.20)	7	0.59	(0.22–1.57)	13	1.23	(0.55–2.74)
Always wood	151	80	1.06	(0.59–1.89)	45	0.81	(0.45–1.24)	66	0.75	(0.45–1.24)
>1/2 coal	9	2	0.82	(0.15–4.56)	2	0.83	(0.16–4.30)	2	0.40	(0.07–2.13)
Always coal	5	2	2.03	(0.28–14.42)	2	0.80	(0.07–8.66)	11	7.46	(2.15–25.94)
Mixed/other	47	10	0.70	(0.28–1.74)	2	0.17	(0.04–0.76)	10	0.52	(0.22–1.22)

Note: Number may differ slightly from Table 1 due to missing values.
[a]Adjusted for centre, age, sex, SES (education, family income, crowdedness) and cumulative tobacco consumption.
[b]Additionally adjusted for alcohol years, chewing tobacco product and snuffing.
[c]Reference category.

observed for lung cancer. When the analysis was restricted to never-smokers, a definitive conclusion could not be drawn for hypopharyngeal and laryngeal cancers due to small numbers of exposed participants (Table 2). However, for lung cancer, for which a reasonable number of cases were available, an increased risk was observed that was higher in magnitude than the one observed for the combined analyses of smokers and non-smokers (OR 7.46 vs 3.76). These findings are further supported by analysis based on the duration of usage (Table 3) which showed a strong dose–response relationship for duration of coal usage and increased risk of lung cancer ($P_{trend} < 0.01$). The findings of increased risk associated with coal usage (OR 7.46, CI 2.15–25.94) observed among the non-smoking population, in conjunction with a strong dose–response relationship observed for duration of coal usage serve to document that coal usage for cooking is a strong risk factor for lung cancer in India. A similar dose–response relationship was also observed for increasing duration of coal usage and the risk of hypopharyngeal cancer ($P_{trend} = 0.06$) and laryngeal cancer ($P_{trend} = 0.05$), suggesting its potential role in the high incidence of head and neck cancer in India.

The increased risk of lung cancer (OR 3.76, CI 1.64–8.63) observed in this study for lifetime users of coal is consistent with a recent meta-analysis of studies conducted in China, which reported a pooled OR of 2.66 (CI 1.39–5.07) for the association between domestic coal usage for heating/cooking and lung cancer.[29] The observed risk of lung cancer among the non-smoking population observed in this study is consistent with a previous study from China which

Table 3 Odds ratios by duration of fuel usage

	Count	Hypopharynx[a,b]			Larynx[a,b]			Lung[a]		
		N	OR	95% CI	*N*	OR	95% CI	*N*	OR	95% CI
Years of wood usage										
Always modern[c]	344	118	1.00		150	1.00		275	1.00	
>0–30	93	35	0.85	(0.50–1.45)	36	0.72	(0.43–1.22)	33	0.49	(0.29–0.83)
>30–50	136	140	1.59	(1.06–2.38)	102	0.99	(0.65–1.52)	154	1.27	(0.87–1.85)
>50	125	205	1.45	(0.96–2.19)	199	0.95	(0.63–1.43)	280	0.95	(0.65–1.37)
		$P_{trend} = 0.03$			$P_{trend} = 0.88$			$P_{trend} = 0.86$		
Years of coal usage										
Always modern[c]	344	118	1.00		150	1.00		275	1.00	
>0–30	16	6	0.96	(0.26–3.57)	3	0.47	(0.10–2.30)	13	1.22	(0.42–3.49)
>30–50	18	8	1.08	(0.37–3.15)	10	1.33	(0.52–3.40)	19	1.99	(0.90–4.43)
>50	4	14	3.47	(0.95–12.69)	22	3.65	(1.11–11.93)	31	3.81	(1.16–12.46)
		$P_{trend} = 0.06$			$P_{trend} = 0.05$			$P_{trend} = <0.01$		

[a]Adjusted for centre, age sex, SES (education, family income, crowdedness) and cumulative tobacco consumption.
[b]Additionally adjusted for alcohol years, chewing tobacco product and snuffing.
[c]Reference category.

Table 4 Odds ratios by self-reported level of smokiness inside homes

	Count	Hypopharynx[a,b]			Larynx[a,b]			Lung[a]		
		N	OR	95% CI	*N*	OR	95% CI	*N*	OR	95% CI
Index of smokiness inside homes										
Level 1[c,d]	284	135	1.00		135	1.00		196	1.00	
Level 2	262	105	0.65	(0.45–0.95)	153	0.99	(0.70–1.41)	246	1.06	(0.78–1.44)
Level 3	76	116	1.67	(1.08–2.59)	91	1.41	(0.89–2.21)	172	1.92	(1.29–2.86)
Level 4	39	67	1.46	(0.83–2.56)	57	1.18	(0.65–2.17)	99	2.14	(1.28–3.56)
		$P_{trend} < 0.02$			$P_{trend} = 0.23$			$P_{trend} < 0.01$		

[a]Adjusted for centre, age, sex, SES (education, family income, crowdedness) and cumulative tobacco consumption.
[b]Additionally adjusted for alcohol years, chewing tobacco product and snuffing.
[c]Reference category.
[d]Level 1: None, cooking done inside, but little smoke.
2: Some smokiness caused by cooking.
3: Much smokiness caused by cooking, but not enough to irritate eyes.
4: Much smokiness caused by cooking, enough to irritate eyes.

reported similar increases in the risk of lung cancer associated with coal usage among non-smoking women.[30] We also observed that with increasing levels of self-reported smokiness inside homes, there was an increasing risk of hypopharyngeal cancer and lung cancer. Since this is a self-reported measure of exposure, recall bias may be a potential limitation; therefore, this finding must be interpreted cautiously. Nonetheless, the findings based on this measure of exposure are consistent with other findings reported in this study, as well as other epidemiological studies that have utilized similar approaches including eye irritation as a proxy for the extent of indoor air pollution and the risk of lung cancer.[31,32]

One possible explanation why exposure to coal smoke appears to be a risk factor for hypopharyngeal/laryngeal and lung cancer, while wood smoke appears to be a risk factor only for hypopharyngeal cancer, may have to do with the size of particles generated during combustion processes. Measurements made inside Chinese homes have shown that more than 50% of particles generated during the process of coal combustion are less than 1μm in size, with the remaining fraction in the range of 1–10 μm in size.[33] In contrast only 6% of particles generated during wood combustion were less than 1μm in size, with the remaining particles in the size range of 1–30 μm. Similar observations were also made in Costa Rican homes where wood burning was practised.[34] Thus, it is plausible that the finer particles generated during coal combustion are likely to penetrate deeper into the lungs, depositing the particle bound carcinogens effectively, while the less finer particles from wood combustion are more likely to be deposited in the upper respiratory tract.

However, it is not clear at this point why wood smoke appears to have some effect on hypopharyngeal but not on laryngeal cancer, given the close proximity of the two sites. In addition, it is unlikely that particle size alone can account for the observed differences in cancer risk between wood smoke and coal smoke exposures. Additional factors including the nature and extent of carcinogens formed during each combustion process are likely to play a more crucial role. Based on the Ames test, mutagenicity of the polar organic fraction of particles collected from smoky coal was as much as 8-fold higher compared with that of particles collected from wood.[35] Furthermore, levels of various known and suspected human carcinogens released during coal combustion inside homes far exceed that formed during wood combustion.[35]

There are several strengths of this study including the large sample size due to its multicentric study design. This study was conducted in areas with a high prevalence of the exposures of interest (indoor air pollution from solid fuels), as well as the outcomes of interest (lung cancer and hypopharyngeal/laryngeal cancer). Very few studies have explored the use of solid fuels for cooking as a risk factor for lung cancer in India, and none have investigated the relationship between hypopharyngeal/laryngeal cancer and solid fuel use in India. A limitation of this study includes potential recall bias associated with the self-reported measure of exposure. Furthermore, it is very difficult to accurately capture exposures experienced by individuals based on the type and duration of solid fuel used, since significant variability is likely to exist even among individuals reporting similar usage history depending upon the ventilation level in the cooking area, house characteristics and household cooking preferences.[36] But such non-differential misclassification is likely to attenuate the ORs. Another potential concern includes residual confounding by smoking, which we tried to address by restricting the analysis to lifetime never-smokers, whenever possible. A careful attempt was made to address confounding by SES by including in the regression model an indicator that incorporated various aspects of it. Additionally, the proportion of female study participants is rather low in this study, which excluded the possibility of restricting the analyses among women only. Since women in India are likely to spend a greater proportion of their time indoors performing various cooking related activities, the intensity of exposure is likely to be higher among women compared with men. Therefore, it would be desirable to have a larger proportion of female participants in order to explore the differential risks between males and females.

In summary, this study is the first to estimate the risk of hypopharyngeal/laryngeal cancer associated with the use of different types of solid fuels in India, where the prevalence of exposure is very high and the incidence of this cancer is among the highest in the world. In addition, this study provides a relative comparison of various solid fuel types and the risk of lung cancer and hypopharyngeal/laryngeal cancer. Findings from this study suggest that the effect of indoor air pollution on respiratory cancer in India is plausible. While exposure to indoor air pollution related to coal usage was a risk factor for lung cancer and, to a lesser extent, hypopharyngeal and laryngeal cancer, exposure to wood smoke may be a moderate risk factor for hypopharyngeal cancer in India.

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Reference

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