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BIOMASS FUEL EXPOSURE AND LUNG CANCER IN FEMALES

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ABSTRACT

It is estimated that about 2.4 billion people around the world use traditional biomass fuels for household cooking or heating. Biomass fuel emissions were categorized as group 2A carcinogen due to epidemiological limitations. Lung cancer is one of the leading causes of mortality worldwide. Smoking is the major risk factor; still 25% cases of lung cancer are non-smoker (more prevalent in female). In this review, we had reviewed the epidemiological evidence of biomass fuel exposure in females as a risk factor for lung cancer.

INTRODUCTION

Indoor air pollution resulting from the use of biomass fuels consisting of firewood, dung cakes, agricultural crop residues, coal fuels and kerosene is a significant health concern in developing countries. In developing countries an estimated 2.4 billion people use biomass or coal for heating and cooking [1]. In India, approximately three quarters of Indian households relies on biomass fuel for cooking [2].

In India, majority of biomass fuels used are wood in 70.7%, crop residue in 13.5% and cow dung cake in 13.1% of total biomass fuel [3]. Emissions from combustion of biomass fuel have been shown to have high concentrations of polycyclic aromatic hydrocarbons (PAHs), benzo(a)pyrene and particulate matter with a diameter of 2.5 µm or less, which in turn is associated with high rates of lung cancer [4]. Lung cancer is one of the leading causes of mortality worldwide. While smoking is the major risk factor for it, still 25% of lung cancer cases are not attributable to smoking [5]. Studies have consistently shown that lung cancer in non-smokers is more common in females than in males [5].

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This review focuses on the lung carcinogenic potential of biomass fuel in females.

Data sources:

The Pubmed medical literature data base was searched for published articles with key-words of 'indoor air-pollution', 'biomass fuel', 'female lung cancer'. The bibliographies of all papers found were searched for further relevant articles. All studies including case-control, retrospective and cross-sectional studies were included.

RESULTS

After thorough search of Pubmed, total 12 studies were found including two meta-analysis, one pooled analysis and nine case-control study were found where the association between bio-mass fuel exposure and lung cancer in female were studied. A review of these studies is discussed.

Study from Mexico (1986-1994) reported an increase in odd ratio (OR) of getting lung cancer (although non-significant) with increase in the duration of cooking years with wood fuel [6]. This study reported a significant effect of wood fuel exposure on women with exposure age of <20 and 20-40 years, but no effect at exposure age >40 years [6]. In an population based case-control study by Wu-Williams et al among 965 female cases and 959

controls reported OR of 1.2 (95% CI 0.9-1.7) for female lung cancer by burning Kang (brick beds heated by stoves underneath) for 1-20 years, which had increased to OR of 1.5 (95% CI 1.1-2.0) after increasing the duration of use to 21+ years [7]. In a hospital based case-control study by Ko et al among 117 cases and 117 controls, ORs of developing lung cancer by using coal or anthracite for cooking were 2.5 (95% CI 1.3-5.1), 2.5 (95% CI 1.1-5.7) and 1.0 (95% CI 0.2-3.9) during three age stages of <20 years, 20-40 years and >40 years respectively [8]. Another hospital based study from Chandigarh among 265 cases and 525 controls revealed the OR of getting lung cancer was 1.11 (95% CI 0.34-3.60) among females by using wood fuels for heating for more than 45 years [9]. Another hospital based case-control study from Japan (1986-1998) among 144 never smoker women and unmatched 731 never smokers, OR of getting lung cancer was 1.77 (95% CI 1.08-2.91) after using straw or wood for cooking at exposure age of 30 years [10]. The greater susceptibility of the growing lung to environmental pollutants and long duration of exposure years may be the reason for these observations.

A case-control study from Chandigarh in 67 female cases and 46 non-cancer respiratory diseases attending a respiratory clinic revealed the ORs of 3.6 (95% CI 1.1-12.0) for developing lung cancer in biomass fuel users versus LPG users which was higher among non-smokers OR of 5.3 (95% CI 1.7-16.7) among never-smokers and 3.0 (95% CI 1.7-8.3) among smokers [11]. Both tobacco smoke and biomass fuel smoke share similar carcinogenic potential leading to synergistic effect between smoking and other indoor air-pollutants, if this would be the case, we would expect stronger associations between smokers than non-smokers as suggested by other studies[12]. Singapore study among 703 female cases and 1578 controls revealed higher ORs of 1.25 (95% CI 0.74-2.12) for getting lung cancer among smokers as compared to ORs of 0.81 (95% CI 0.56-1.17) among non-smoker after using wood-stoves at period of 25 years prior to diagnosis [12].

The impact of indoor air pollution from biomass fuel on the risk of carcinogenesis in the airways was studied by Roychoudhury S et al (2012) in 187 women who cooked exclusively with biomass and 155 age-matched control women from the same locality who cooked with liquefied petroleum gas (LPG) [13]. This study showed 3-times higher prevalence of metaplasia and 7-times higher prevalence of dysplasia in airway epithelial cell of biomass fuel users [13]. This study further concludes that cumulative exposure to biomass smoke increases the risk of lung carcinogenesis via oxidative stress-mediated activation of Akt signal transduction pathway [13].

International agency for research on cancer (IARC) classified indoor emissions from household coal combustion are group 1 carcinogenic to human whereas indoor emissions from biomass (primarily wood) were labeled as probable human carcinogen [14]. To further elucidate this association, a pooled analysis was conducted by International lung cancer consortium (ILCCO) [15]. This Pooled analysis revealed the OR of 1.64 (95% CI, 1.49-1.81) among predominant coal users, OR of 4.93 (95% CI, 3.73-6.52) among coal users in Asia and OR of 1.21 (95% CI, 1.06-1.38) among North American and European countries [15]. This result is consistent with previous observations [6-14] and further confirms the carcinogenic potential of in-home wood.

A recent meta-analysis (2012) revealed higher OR 1.82 (95% CI 1.60-2.06) with coal smoke as compared to OR of 1.50 (95% CI 1.17-1.94) with biomass fuel smoke as lung carcinogen [16]. This analysis further concludes that risk of lung cancer was greater in females and in china as compared to males which could be because of predominant coal user by Chinese women [16]. These findings supports that both coal and biomass burning in-home is consistently associated with an increased risk of lung cancer.

Another case-control study in female cancer cases by Mondal NK revealed an odd ratio of 5.33 (95% CI 1.7-16.7) for biomass fuel exposure among non-smokers which was higher than the risk (OR=3.04, 95% CI 1.1-8.38) associated with the use of mixed fuels[17]. After adjusting for smoking and passive smoking, biomass fuel exposure was still significant with OR of 3.59 (95% CI 1.07-11.97) [17].

A recent systematic review revealed that ORs for lung cancer risk with biomass fuel used for cooking and/or heating were 1.17 (95% CI 1.01 to 1.37) overall and 1.15 (95% CI 0.97 to 1.37) for cooking only [18]. Sensitivity analysis restricted to adequate adjustment and a clean reference category found ORs of 1.95 (95% CI 1.16 to 3.27) for women [18]. Exposure-response evidence further revealed higher risk for women in developing countries as compared with developed countries, consistent with higher exposure in the former [18].

Evaluating the evidence:

Overall, the epidemiological studies are suggestive of the association between female lung cancer and use of bio-mass fuel. Most of studies are case-control design and hospital or clinic based; risk of selection bias is higher in these groups.

The different result from these studies could be because of the fact that exposure level to the toxic fumes from a biomass fuel varies widely with the architecture and composition of house. In many Indian houses, either cooking areas tends to be poorly ventilated due to lack of chimneys/other mode of ventilation or do not have a separate kitchen. The exposure is further influenced by climatic and cultural variation between northern and southern India. Study from Chennai reported the use of biomass fuels for cooking in 36% houses with indoor kitchens without partitions, 30% houses with separate

kitchen and 16% in an outdoor kitchen [19]. The individual exposure level to respirable particles in biomass smoke does not differ by using either an indoor kitchen with or without partitions or using a separate kitchen outside the house but it does differ for cooks using open outdoor kitchens as emissions are dispersed more outdoors. Therefore cooks using an open outdoor kitchen have less exposure than cooks using an enclosed kitchen. Households with kitchens without partitions have higher concentrations of particles in living areas. Young children and elderly often occupy living areas leading to higher levels of exposure in un-partitioned indoor kitchens. Among individuals not using bio-mass fuels, women not involved in cooking and men with outdoor jobs had the lowest exposure, while women who cook and men staying at home had the highest level of exposure. Other factors like socio-economic status, nutrition may also affect the associations [20]. Relative to smoking, biomass fuel emissions are low risk agents for lung cancer and their effects may be masked when studied in population with high smoking prevalence [9].

CONCLUSIONS

The available evidence indicate that biomass fuel exposure is an important risk factor in the causation of lung cancer among women in addition to smoking, but future studies need to be done for better exposure assessment to strengthen exposure-response evidence.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

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