Introduction
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Domestic cooking is an important duty of an average Indian housewife. On an average, an Indian woman spends about four to six hours daily for cooking. Mainly following different types of cooking fuels are used in this country: biomass fuel (Wood, Cow-dung cake, Animal dung cake, agricultural waste, coal etc.); liquefied petroleum gas (LPG); kerosene and a mixture of these. Around 50% of the world’s population and 75% of those living in developing countries rely on biomass fuel. About 95% of the rural population in India still relies primarily on biomass fuels (animal, dung, crop residues and wood) for cooking and heating. These biofuel are usually burnt in open fire on simple stoves which result in very high levels of exposure particularly for woman and young children.

Use of these fuels cause a number of respiratory problems, which include acute respiratory infections in children, chronic obstructive lung disease in nonsmokers. It has also been implicated as a risk factor for lung cancer and TB in woman. Use of unprocessed solid fuel causes indoor air pollution with high concentration of PM$_{10}$ particles. Biomass smoke, contains a wide-range of chemicals that are known suspected human carcinogens. Thus, they may be important risk factors for development of lung cancer and tuberculosis. Studies
from China and India have shown that coal burning at home is a significant risk factor for development of lung cancer in non-smoking females. Coal smoke contains many potential carcinogens like \( \text{SO}_2 \), CO, TSP, radon, thoron. Use of kerosene for cooking has also been seen associated with development of lung cancer as reported in some studies (Koo et al. 1983). In the present study we have tried to find out the role of domestic cooking as a risk factor in the development of lung cancer, blood related disease and TB in non-smoking rural woman.

Majority of people think that, air pollution is associated with the contamination of urban air from automobile exhausts and industrial effluents. However, in developing countries, the problem of indoor air pollution far outweighs the ambient air pollution. There are four principal sources of pollutants of indoor air (i) combustion (ii) building material (iii) the ground under the building and (iv) bioaerosols. In developed countries the most important indoor air pollutants are radon, asbestos, volatile organic compounds, pesticides, heavy metals, animal dender, mites, moulds and environmental tobacco smoke. However, in developing countries the most important indoor air pollutants are the combustion products of unprocessed solid biomass fuels used by the poor urban and rural folk for cooking and heating.
Approximately, half of the world's population and up to 90% of rural households in developing and under developing countries still rely on unprocessed biomass fuels such as wood, dung and crop residues. A recent report of the World Health Organization, asserts the rule of 1000, which states that a pollutant released indoors is one thousand times more likely to reach people's lung than a pollutant released outdoors (WHO, 1999). It has been estimated that about half a million women and children die each year from indoor air pollution in India (Smith et al. 2000). Compared to other countries, India has among the largest burden of disease, due to the use of dirty household fuels and 28% of all deaths due to indoor air pollution occur in India.

The type of fuels used by a household is determined mainly by its economic status. In the energy ladder, biomass fuels namely animal dung, crop residues and wood, which are the dirtiest fuels, lie at the bottom and are used mostly by very poor and middle class people living in rural areas. Electricity, which is the most expensive, lies at the top of ladder and it is also the cleanest fuel. The 1991 National Census for the first time, enquired about the fuel used for cooking. It revealed that about 90% of the rural population relied upon the biomass fuels like animal dung, crop residues and wood. A small portion used coal. Nation-wide about 78% of the population relied upon the biomass fuels and 3% on coal (NFHS, 1995). Other sources of indoor air pollution in villages include smoke entering the home from nearby houses, burning of forests,
agricultural land and household wastes. Environmental tobacco smoke is another source of indoor air pollution exposures. It is important to recognize that the open hearth and resulting smoke after have considerable cultural and practical value in the home.

Some of the highest exposure to air pollution in developing countries occurs inside homes where biofuels are used for daily cooking. Biomass fuel emitting smoke is used mostly in rural and poor urban areas. It's composed of complex organic matter, vegetable protein and carbohydrates incorporating carbon, nitrogen, oxygen, hydrogen and certain other elements in trace amounts which may affect health of individual adversely.

Biomass fuel (animal dung, agricultural wastes, coal and firewood) is an important source of energy in many parts of the world particularly in India, Asia and Africa for various purposes. Biomass smoke contains many thousand of substances, many of which damage human health. Most important are particulates, carbon monoxide, nitrous oxides, sulphurdioxide, formaldehyde and polycyclic matter which include carcinogens, such as benzopyrene. Small particles are able to penetrate deep into the lungs and appear to have the greatest health damaging potential.

During combustion, the biomass fuel produces various irritant gases which are harmful to health. The stoves or chullah used for cooking are not
energy efficient. The fuels are not burned completely. The incomplete combustion of biomass releases complex mixture of organic compounds, which include suspended particulate matter, poly organic material and poly aromatic hydrocarbons. The biomass may also contain intrinsic contaminants such as sulphur, trace metals, and heavy metals also. Incomplete combustion of fuels produces carbon monoxide (CO). The carbon monoxide and particle emission cause a serious problem, when biomass fuels are used. Smith has estimated that about 38, 17, 5 and 2 g/meal carbon monoxide is released during the household cooking using dung, crop residues, wood and kerosene respectively. During the use of liquid petroleum gas (LPG) a negligible amount of carbon monoxide is released. A study by the National Institute of Occupational Health (NIOH), Ahmedabad, reported indoor air carbon monoxide levels of 144, 156, 94, 108 and 14 mg/m³ air during cooking by dung, wood, coal, kerosene and LPG respectively.

Poly organic material is a loose term used to depict a group of chemicals having two or more rings. Of several chemicals included in this group, the PAHs have attracted interest for their possible carcinogenic effects. Study by NIOH showed that the indoor levels of PAH during use of dung, wood, coal, kerosene and LPG were 3.56, 2.01, 0.55, 0.23 and 0.13 µg/m³ of air respectively. These PAH were fluorine, pyrene, chrysene, benzo(a)
anthracene, benzo fluoranthene, benzopyrene, dibenzo-anthracene and indenol pyrene. All these PAHs have been classified as possible carcinogens.

Patel and Raiyani (1993) measured levels of formaldehyde in indoor environment during cooking by different fuels. The formaldehyde mean levels were 670, 652, 109, 112 and 68 µg/m³ of air for cattle dung, wood, coal, kerosene and LPG respectively. The formaldehyde is well recognized to be an acute irritant and long-term exposure, can cause a reduction in vital capacity and chronic bronchitis.

In India, nearly 75% of the household energy consumption is accounted by traditional biomass fuels (wood, crop residues, and animal dung). These fuels are used in inefficient stoves, which emit substantial amount of fuel carbon as products of incomplete combustion. This includes GHGs such as methane and total non-methane organic compounds, as well as health-damaging pollutants (HDP) such as respirable particles carbon monoxide, benzene, and formaldehyde. Measured levels of health damaging pollutants from biomass stoves are more than 10 times higher than corresponding standards of outdoor air (WHO, 1999). Exposures to these pollutants has been shown in many recent studies to be casually linked with several health effects including acute respiratory infection, chronic obstructive lung disease, adverse pregnancy outcomes, and eye diseases. Woman who cook with these fuels and
children living in these homes, face high risk from such exposures. Recent estimates of the burden of diseases, attributable to use of bio-mass fuels in India. Given, the widespread prevalence of solid-fuel use, and the emerging scientific evidence of health impacts associated with exposures to emissions from solid-fuel use. Indoor air pollution issues, in rural households of developing countries are of tremendous significance from the standpoint of population health.

The health outcomes chosen for calculations are COPD (Chronic Obstructive Pulmonary Disease), ALRI (Acute Lower Respiratory Infections) and TB. COPD and ALRI have been shown to have strong associations with solid fuel use, whereas TB has moderate association with solid fuel use. This estimate burden of diseases is attributable to indoor air pollution from analysis of many developing countries, via studies relating solid fuel use of health impacts. The same relative risk, can be used for local assessments as the nature and level of indoor air pollution caused by solid fuel use is similar across settings, exposure to such fumes may result in wide and variable side effects.

Domestic cooking with kerosene stove, coal lighted, angithi and gas stove (LPG) are more commonly used in urban areas. In rural areas of all developing countries including India, biomass based fuel is the principal source of fuel energy, used for cooking and heating in the rural household in poorly
ventilated houses. Clinical studies suggested that, the use of some of the above described fuels particularly, fire wood and cow dung cakes is associated with chronic bronchitis and functional changes of airway obstruction Behara et al. (1994) observed the respiratory symptoms of Indian women using domestic cooking fuels and the ventilatory impairment seems to be more of the restrictive type. Chronic bronchitis is a major respiratory disease, widely prevalent in north India. Among the males, prevalence of chronic bronchitis is commonly associated with the history of tobacco smoking. However, in the females, mostly housewives, many of whom have never smoked tobacco, the etiology of chronic bronchitis is not clearly understood. Chronic exposure to irritant fumes, produced while cooking with fuels particularly the coal lighted, angithi or on chullas using bio-matter solid waste mixed with firewood have been considered as an important cause of chronic bronchitis in the female. A high incidence of chronic bronchitis was reported among the residents of rural Nepal hills, due to domestic smoke pollution caused by indigenous cooking fuels (Pandey, 1984). Domestic cooking with stoves, lighted with kerosene oil or low pressure petroleum gas (LPG) also produce respiratory irritants (Anura et al. 1975., Spenglar et al. 1979). The deleterious health effects of exposure to biomass fuel on various systems of the human body have been reviewed. These are carbon monoxide poisoning, irritation of eyes and respiratory tract, lower respiratory tract disease, chronic obstructive pulmonary disease, cor pulmonale


of life and ill health, far greater than the more often discussed outdoor air pollution.

Biomass smoke contains many harmful constituents such as respirable particulates and carbon monoxide, exposure to which can cause or contribute to acute respiratory infections, pneumonia, tuberculosis, lower birth weights, cataract, nervous and muscular fatigue. Smoke, especially coal smoke, also contains sulphur and nitrogen oxides and hydrocarbons which can lead to cancer. Women and children are most exposed to high levels of harmful smoke and suffer the most serious health damage; respiratory infections alone, cause between 4 and 5 million deaths per year among small children, which is equal to or marginally less than deaths from diarrhoeal diseases. Some 1.9 million additional deaths, each year are blamed on rural indoor pollution through suspended particulate matter and another 450,000 deaths are attributed to urban indoor air pollution. African countries and India have the worst record. Several studies in China, found that smoke was a strong risk factor for lung cancer among nonsmoking women, while another study in Japan has related lung cancer to the past use of biofuels in cooking.

In developed countries, modernization has been accompanied by a shift from biomass fuels such as wood to petroleum products and electricity. In developing countries, however, even where cleaner and more sophisticated
fuels are available, households often continue to use simple biomass fuels. Although, the proportion of global energy derived from biomass fuels fell from 50% in 1900 to around 13% in 2000, there is evidence that their use is now increasing among the poor. Poverty is one of the main barriers to the adoption of cleaner fuels. The slow pace of development in many countries suggests that biomass fuels will continue to be used by the poor for many decades.

Around 50% of people, almost all in developing countries, rely on coal and biomass in the form of wood, dung and crop residues for domestic energy. These materials are typically burnt in simple stoves with very incomplete combustion. Consequently, women and young children are exposed to high levels of indoor air pollution every day.

There is consistent evidence that indoor air pollution increases the risk of chronic obstructive pulmonary disease and of acute respiratory infections in childhood, the most important cause of death among children under 5 years of age, in developing countries. Evidence also exist of associations with low birth weight, increased infant and prenatal mortality, pulmonary tuberculosis, nasopharyngeal and laryngeal cancer, cataract, specifically in respect of the use of coal, with lung cancer. Exposure to indoor air pollution may be responsible for nearly 2 million excess deaths in developing countries and for some 4% of the global burden of disease. The significance of exposure to indoor air
pollution and the increased risk of acute respiratory infections in childhood, chronic obstructive pulmonary disease and lung cancer, the health effects have been somewhat neglected by the research community, donors and policy-makers. We present new and emerging evidence for such effects, including the public health impact. We consider the prospects for interventions to reduce exposure, and identify priority issues for researchers and policy-makers.

Indoor air pollution is a major global public health threat, requiring greatly increased efforts in the areas of research and policy-making. Research on its health effects should be strengthened, particularly in relation to tuberculosis and acute lower respiratory infections. A more systematic approach to the development and evaluation of interventions is desirable, with clearer recognition of the interrelationships between poverty and dependence on polluting fuels.

Biomass fuel is any material, derived from plants or animals, which is deliberately burnt by humans. Wood is the most common example, but the use of animal dung and crop residues is also widespread. China, South Africa and some other countries also use coal extensively for domestic needs.

About three billion people worldwide use biomass fuel (e.g. wood, agricultural residues, dung) for cooking and household energy. Due to incomplete combustion, biomass produces a number of toxic and carcinogenic
elements and particulate matter that have been associated with chronic obstructive pulmonary disease and acute respiratory infection among women and children. Recently, assessment of pollutants from biomass combustion in a group of non-smoking women in Bangladesh by measuring fine PM, lung functions and biomarkers for polycyclic aromatic hydrocarbon was done.

In general, the types of fuel used become cleaner and more convenient, efficient and costly as people move up the energy ladder. Animal dung, on the lowest rung of this ladder, is succeeded by crop residues, wood, charcoal kerosene, gas and electricity. People tend to move up the ladder as socioeconomic conditions improve. Other sources of indoor air pollution in developing countries include smoke from nearby houses, the burning of forests, agricultural land and household waste, the use of kerosene lamps, and industrial and vehicle emissions. Indoor air pollution in the form of environmental tobacco smoke can be expected to increase in developing countries. It is worth noting that fires in open hearths and the smoke associated with them often have considerable practical value, for instance in insect control, lighting, the drying of food and the flavouring of foods.

Biomass fuel smoke cause eye irritation also and may cause cataract, nasopharyngeal carcinoma, respiratory illness, chronic pulmonary diseases and asthma.
The majority of households in developing countries burn biomass fuels in open fireplaces, consisting of such simple arrangements as three rocks, a U-shaped hole in a block of clay, or a pit in the ground, or in poorly functioning earth or metal stoves. Combustion is very incomplete in most of these stoves, resulting in substantial emissions which, in the presence of poor ventilation, produce very high levels of indoor pollution. Indoor concentrations of particles usually exceed guideline levels by a large margin: 24-hour mean PM$_{10}$ levels are typically in the range 300-3000 $\mu$/m$^3$ and may reach 30,000 $\mu$/m$^3$ or more during periods of cooking.