BIOMASS FUEL SMOKE: A SILENT KILLER

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Solid fuels use is defined as the domestic combustion of organic materials such as animal dung, crop residues, wood and coal used for cooking, lighting and heating purposes. These sources include wood, dried twigs and grass, crop residues, and animal dung cakes, which collectively are called biomass fuels. Although in developed world these highly polluting fuel sources have been replaced with cleaner sources, such as liquified petroleum gas and electricity, it is estimated that still nearly 50% of all house-holds worldwide and 90% of all rural households continue to use biomass fuel as their main domestic source of energy[1]. On a global scale, the household use of solid fuels is the most important source of indoor air pollution and the exposure to the by-products of the combustion of biomass fuels, particularly wood smoke, has been related to numerous respiratory problems, and increased mortality and burden of disease[1]. Recent data attribute 1.5 to 2 million deaths worldwide every year equivalent to 4 to 5 % of total global deaths to indoor air pollution and most of them (1 million) occurring in children younger than 5 years due to acute respiratory infections (ARI)[2]. In fact, the emerging data from recent studies indicate that risk-wise biomass fuel smoke ranks only below malnutrition and poor quality of water / sanitation[3, 4]. Similarly worldwide today, indoor air pollution ranks tenth while in developing countries it ranks fourth among preventable risk factors contributing to the global burden of disease[5-7].

Approximately half of the world's households use solid fuels including biomass and coal for cooking and home heating[7, 8]. In developed countries, particularly Canada and Australia, and in some states of the United States of America, the persistent rise of the costs of energy has prompted an increasing number of households to use wood or any other biomass product for heating[9].

The use of solid fuels is closely linked to the gross national product per capita, and in general, in the same geographic zone, the use of solid fuels is higher in households with lower income[10]. The global energy derived from biomass fuels has fallen from 50% in 1900 to nearly 13% in 2000, but recently it seems to be increasing, especially among the poor. The current socioeconomic situation in many developing countries suggests that the use of biomass fuels will continue in the coming decades[2]. In these countries, nearly 2 billion kilograms of biomass are burned every day[11, 12]. The total annual average of wood production used for fuel in developing countries increased approximately 16.5%over the past decade to about 1.55 billion cubic meters[13].

Pakistan is one of the largest populated country with 66% rural population, per capita GNP of US$ 430, female adult literacy rate of 33%, 62% population with access to safe drinking water, 43.3% population under 15 years, human development index of 0.499, 42% population with adequate excreta disposal facilities, infant mortality (per 1000 live birth) of 85. 43 million people have been estimated to be affected by drought and a major (60 to 80%) burden of diarrheal diseases is caused due to poor access to safe water, inadequate sanitation and unsafe food[4]. In Pakistan nearly 94 % of the population in rural areas and 60% in the urban areas are depending on biomass. Wood accounts for 54%, dung 18% and crop residues for 14% and approximately 83% is used for the purpose of cooking[12].

Solid fuels are commonly burned in inefficient simple stoves and in poorly ventilated conditions. In such situations, solid fuel burning is incomplete and generates substantial emissions of many health-damaging pollutants, including respirable particulates, carbon monoxide, nitrogen oxides, benzene, formaldehyde, 1,3 butadiene, and polyaromatic compounds such as benzo(α)pyrene. Research has shown that wood smoke is a complex mixture of numerous volatile and particulate

substances constituted by different organic and inorganic compounds, and its composition varies with the fuel and the conditions of combustion. More than 200 chemical and compound groups have been identified, which are almost all (> 90%) in the inhalable size range with mean aerodynamic particulate matter diameters less than 10 mm (PM10). When these fuels are used in poorly ventilated conditions and burnt in open fires or inefficient stoves, conditions common in households throughout the developing world, biomass fuel combustion may result in indoor air pollutant levels well above those in even the dirtiest of cities of the word[14, 15].

In homes that use biomass fuels, the mean 24-h PM10 levels have been shown to reach 300 to 3,000 µg/m^3 and sometimes can be as high as 30,000 µg/m^3 [1]. Daytime respirable particulate measurements in homes using biomass fuel in China, Kenya, Mexico, Guatemala, Brazil, and India show average PM 10 levels of about 1,000 mg/m^3 but easily reach levels up to 3,000 µg/m^3 [16]. The US Environmental Protection Agency (EPA) safety standard for 24-h average PM 10 exposure is 150 µg/m^3. The levels encountered in homes that use biomass fuel are therefore about 10 to 70 times above ambient levels observed in some of the most polluted cities of the world. Moreover, the mean CO concentrations in homes that use biomass fuel are typically in the range of 2 to 50 ppm but can be as high as 500 ppm during cooking, which is significantly greater than the EPA 8-h safety standard for CO (< 9 ppm)[17].

Women and children are among the most exposed population to biomass smoke. Young girls spend substantial amount of time indoors helping their mothers and learning cooking skills. Infants being carried on the back of mother are exposed to biomass smoke right from the beginning of their life cycle[18]. Toddlers are exposed while playing around or near stove. The extent of exposure is high in the microenvironment where ventilation is poor[19]. The situation get further worse when in small households the single room is used for multiple household activities during the day time, living room in the evening and as a bed room at night. This combined with inappropriate ventilation and inefficient stoves, the adverse health effects of exposure to indoor pollutants are far worse than expected[20].

Adults chronically exposed to biomass fuel smoke show the presence of multiple dark anthracotic pigmentations in the large airway mucosa,[21] mainly due to deposition of carbon particles, iron, lead, cadmium, silica, phenol, hydrocarbon complexes, and other inorganic and organic substances in the respiratory tract mucosa[22]. Many of these substances have strong oxidant properties that induce chronic inflammatory and destructive changes in the airways and alveoli. Wood smoke and other biomass exposure have been shown to be independent risk factors for obstructive airways disease, and earlier and longer time of exposure has been shown to increase the risk for development of COPD[23]. Chronic exposure to biomass smoke has been shown to be associated with low birth weight, increased infant mortality increased risk of ear and lower respiratory tract infections in children, reduced lung function in children and adults, and increased risk of asthma, lung cancer and pulmonary TB[24-30]. Exposure to biomass smoke has been linked to interstitial lung disease (wood smoke pneumoconiosis or fly ash lung)[31-33].

Effect of biomass on cardiovascular health has also been speculated in relation with the presence of respirable particulate matter in smoke. Environmental health studies have reported that long term exposure to particulate air pollution increase the risk of all cause mortality and cardiac health[34]. Though there is not much evidence available which might show the association of biomass smoke with cardiac health, recently exposure to biomass has been shown to increase diastolic blood pressure in women from Guatemala[35].

BIOMASS FUEL SMOKE AND COPD

Worldwide, the prevalence of chronic bronchitis ranges from 3% to 27%[36]. A local study conducted on the rural population of Peshawar showed an annual prevalence of 7.01% of COPD using biomass fuel[37]. In developed countries smoking is one of the primary risk factors for the development of chronic bronchitis[38]. In rural areas of developing countries, on the other hand, where smoking is uncommon among women, studies have shown similar rates of chronic bronchitis between men and women. This high prevalence of COPD in female is explained by smoke from domestic biomass fuel combustion[39].

The results of a meta analysis of 15 studies from various countries including Saudi Arabia, Turkey, Pakistan, India and China has shown that exposure to biomass fuel smoke was found to be associated with a 2.3-fold increased risk of COPD[40]. This strength of the association observed between exposure to biomass smoke and COPD is higher than that reported for the association of COPD with passive smoking (odds ratio:1.48)[41] and similar to that of cigarette smoking (OR, 2.12-3.77)[42], occupational exposure (OR, 2.11)[43], This meta analysis also showed an additive effect for the risk of COPD due to tobacco smoking and exposure to biomass smoke when compared with exposure to biomass smoke alone (OR, 4.39 [3.4-5.7] vs 2.55 [2.0-3.1], respectively)[40]. In other words, biomass fuels pose as great risk as active smoking and a greater threat than passive smoking,

thus matching and beating two factors traditionally considered to be major causes of COPD. This finding is more alarming for developing countries as the trend of tobacco smoking has increased, and a concomitant risk of exposure to biomass smoke will further compound the risk of developing COPD in this population. The fact that 3 billion people currently are exposed to biomass smoke worldwide compared with 1.1 billion smokers, it seems likely that exposure to biomass smoke is the biggest risk factor for COPD globally. Indoor air pollution from biomass smoke, therefore, is a bigger threat to human health than outdoor air pollution. The World Health Organization has ranked indoor air pollution as the 10th most important preventable risk factor causing burden of disease, whereas in developing countries, it is the 4th most important preventable risk factor[7].

A wide range of interventions are available to reduce the exposure to indoor air pollution and these interventions can be employed at various levels. For example the use of biomass is closely related with socio-economic status of households, so development and improving the economic condition and introduction of cost effective measures is important to limit the exposure to indoor pollution. Changes in energy technology, such as, A: Switching from bio-mass fuels to cleaner fuels like kerosene, liquid petroleum gas, biogas, solar energy, B: Separating the cooking area from bed rooms and living area, C: improving the ventilation system of the house as adequate home ventilation is mandatory to reduce exposure. Ventilation in kitchen and other rooms can also be improved by incorporating mechanical devices like exhaust fans, D: Improving the design and construction of locally made traditional stoves by the use of chimney, fume hoods to make it more energy efficient and cost effective. Maintaining the height of the stove at a certain level is important to avoid close contact with smoke, E) Encouraging the use of stove less frequently during the day, and F) Avoiding accompanying children during cooking and restricting them from coming close to the stove during cooking.

The literacy rate is generally low especially in our rural populations and awareness on health effects of indoor air pollution is generally lacking, so awareness-raising activities on the adverse effect of indoor air pollution on health need to be promoted especially in the targeted population.

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