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Impact of Indoor Air Pollution on Respiratory Infections in Rural Population

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Abstract - The present review focuses the indications regarding exposure to indoor air pollution and different respiratory infections in rural areas and suggestions for reducing the indoor pollution and subsequently solving related health problems. Half of the world's population in rural areas uses biomass fuel for their daily needs but the resultant emissions and indoor air pollution (IAP) are harmful to health and their impact on respiratory system diseases is strong. Indoor air pollution (IAP) resulting from the use of solid fuel for cooking and heating in villages possesses the majority of the toxins found in tobacco smoke is a significant public health concern in developing countries, is a causative or contributory factor to, Chronic Obstructive Pulmonary Disease (COPD), (if exposed to coal smoke), acute respiratory infection, pulmonary cancer in women and acute respiratory infection in children. Other diseases associated with tobacco smoke, such as tuberculosis, respiratory tract cancer and asthma may also be related with solid fuel smoke inhalation. It is evidenced that exposure probably causes exposed people to be less able to fight off new Mycobacterium tuberculosis infections. Unhealthy cooking is one of the major cause of mortality and morbidity and a risk factor for occurrence of tuberculosis among Indian women. India is assumed as TB burden country in the whole world and accounts for about 20 percent of global load of tuberculosis. The present review will emphasize the association between unhealthy cooking conditions (use of biomass fuels in chulhas, cooking in rooms used for multi-purpose, in less or non-ventilated kitchen, living in semi-pucca and kutcha houses) and prevalence of tuberculosis and other respiratory infections in women of different rural areas. Concentrations of particulate matter in kitchens increase to the range of milligrams per cubic meter during cooking. It is proved from various studies that the occurrence of different respiratory diseases mainly is based on the type of fuel used, kitchen locations and house types and the results of various studies are in favour of that the women using biomass fuels/chulhas cooking in non-ventilated kitchens and multipurpose room, living in kutcha/semi pucca houses are most prone to different respiratory infections and tuberculosis. The reduction in indoor air pollution can be accomplished by giving health education, improvements in household ventilation of kitchen area and improvements in use of better stove options and changes of the fuels for cooking. It should be high priority and urgent task to get better the indoor air quality in households in the rural areas.

Key words - Indoor Pollution, Respiratory Infection, COPD,Tuberculosis,Ventilation

I. INTRODUCTION

Indoor air pollution states the occurrence of pollutants inatmosphere arising from different sources as fuel combustion for heating or cooking; from stored substances, furnishings and carpeting.IAP is a significant cause of morbidity and mortality.In developing countries, especially in rural areasthe problem of indoor air pollution is more in comparison to ambientout door air pollution. Most common principal sources of pollutants of indoor air [1](i) Combustion, (ii) Buildingmaterial, (iii) The ground under the building, and (iv) Bio aerosols. In developed nations the maximumsignificant indoor air contaminants are volatile organic compounds, pesticides, radon, asbestos, moulds, heavy metals, animal dander, mites, and environmental tobacco smoke .However, in rural areas of developing countries the most important indoor air pollutants are the combustion products of unprocessed solid traditional biomass fuels such as wood, crop residues, and animal dung used by the poor urban and rural folk for cooking and heating.Levels of Indoor air pollution has been recorded from burning of biomass. Biomass accounts for more than 80% of domestic energy in India [2], and about 90% biomass is utilized by households of the country in form of wood or animal dung as their primary cooking fuel [3]. IAP is for example supposed to be the 10th most important risk factor in terms of its globalburden of disease and is believed to reasonof two tomes deaths (approximately 1.6 million, out of which two thirds are among children; [4] and fourtimes the number of disability adjusted life years produced by urban outdoor air pollution [5]. Indoor air pollution is also associated to critical respiratory infections which are theprincipalsource of globaldeath in children five years old or younger [6, 7]. When attention is focused on the problem of indoor air pollution resulting from the use of 'biomass fuels' (BMF), an enormous health burden is uncovered. There is now evidence linking an increased risk of respiratory tract infections, exacerbations of inflammatory lung conditions, cardiac events, stroke, eye disease, tuberculosis (TB), cancer and nosocomial infections with air pollution levels [8–15]. Data relating to the effects of burning BMF on health are of relevance to any physician practising in the developing world, however they are conspicuously underrepresented in

the literature [16]. This review will focus the health effects of indoor pollution children and adults of rural population regarding respiratory illness.

II. BIOMASS FUEL AND ITS TOXIC PRODUCTS

Organic materials such as charcoal, wood, plantresidues dried dung, and firewood etc. which are derived from plant residues and used as fuel, are collectively called biomass. BMF biomass account for more than one-half of domestic energy for daily necessities such as heating and cookingin most developing countries and for as much as 95% in lower income countries [15].Biomass fuels are carbon-basedresourcescreated in a renewable way are of two groups according to their sources, woody fuels and animal waste. Woody fuel includes six subgroups of woody fuels as forestry residues, mill residues, agricultural residues, urban wood and yard wastes and chemical recovery fuels (black liquor). Animal wastes comprisefertilizers, executions, and other litters from livestock concludingprocesses. The most common biomass technologies for animal manures are combustion, anaerobic digestion, and composting. Theses have low energy densities compared to fossil fuels means that the costs of fuel collection and transportation can quickly outweigh the value of the fuel. Biomass fuels are usuallyspent on-site or taken for small distances only (e.g., not as much of than 50 miles). Presence of high moisture content, increases the cost of transportation and decreases combustion performance.There are two primary factors are important to check the quality of biomass fuels: one is fuel supply, and other is cost . About almost 3 billion people in the world use solid fuels out of theses 2.4 billion people rely on BMF as their main source of domestic energy for cooking, heating and lighting[15,17] and a further 0.6 billion people use coal. In India, out of 0.2 billion public using fuel for cooking; 49% use firewood; 8.9% cow dung cake; 1.5% coal, lignite, or charcoal; 2.9% kerosene; 28.6% liquefied petroleum gas (LPG); 0.1% electricity; 0.4% biogas; and 0.5% any other means.[18].These fuels are often burned inefficiently in open fires, with high emission factors, leading to extremely high levels of indoor and local air pollution, many times higher than the limits specified by international standards of ambient air quality. Although open fires have energy efficiencies of only 5–10%, users perceive additional benefits, including space heating, protection from insects, and the flexibility of using a wide variety of fuels in different seasons[19].Highest Biomass and coal smoke give off many unhealthy pollutants, including particulate matter that may damage the lungs by causing inflammation, reduced ciliary clearance, and impaired immune responseHousehold usage of solid fuels is the maximumcommon source of indoor air pollution world-wide; solid fuels are extensively used for cooking and home heating in developing countries, especially in rural areas.11–13.Solid fuel use has other negative household effects: as inefficient stoves waste fuel and drain disposable income for fuel purchases where biomass fuels are not freely available for collection. Collection of biomass fuels often takes many hours each week, and can place those collecting it in potentially hazardous situations, vulnerable to landmines, snake bites, and violence; etc.Four factors that appear to be most relevant in a household's choice of fuel type are: (a) cost of fuel, stove type and accessibility to fuels; (b) technical characteristics of stoves and cooking practices; (c) cultural preferences; and lastly, if at all, (d) the potential health impacts [20].Inefficient burning of BMF on an open fire or traditional stove generates large amounts of particulate matter as well as carbon monoxide, hydrocarbons, oxygenated organics, free radicals and chlorinated organics [21].The particulate matter component of this smoke is classified according to its size, with inhalable material <10 μm in aerodynamic diameter referred to as PM_{10}. The 24-h mean particulate matter levels set in the WHO guidelines for air quality are 50 $\mu g/m^3$ for PM_{10} and 25 $\mu g/m^3$ for $PM_{2.5}$ but in many parts of the developing countries the peak indoor concentration of PM_{10} often exceeds 2000 $\mu g/m^3$ [22, 23]. Critically, there are age, gender and socioeconomic differences in levels of exposure and the consequent health effects [6]. Exposure to BMF has been estimated to have caused 0.5% of all deaths and 0.4% of all disability-adjusted life-years in South Africa in 2000 [24, 25]. The smoke from biomass fuel contains noxious materials, including carbon monoxide (CO), nitric oxide (NO), and sulphur oxides (SO), formaldehyde, polycyclic organic matter (POM), and benzopyrene. More than 500 million people in the world are exposed to the smoke and noxious molecules emitted from burning these fuels. [26].In view of the high concentrations of the many hazardous substances in smoke, exposure to indoor air pollution is particularly important for homemakers and young children, and accounts for a substantialproportion of the global burden of disease in developing countries. Many studies reveal that exposure to biomass smoke can markedly increase the prevalence of respiratory disorders [27, 28].

III. HEALTH EFFECTS OF INDOOR POLLUTION

The effect of air pollutants in general would dependon the composition of the air that is inhaled which willdepend on the type of fuel used and the conditions ofcombustion, ventilation and duration for which theinhalation occur. The bad effects of indoor air pollution will be responsible for about two millionunfortunate deaths per year, wherein 44% are due to pneumonia, 54% from chronic obstructive pulmonary disease (COPD), and 2% from lung cancer. [29]The most commonly reported and obvioushealth effect of indoor air pollutants is the increase in the incidence of

respiratory morbidity.The majority of relevant associateddiseases [15] are acute respiratory infections and chronic bronchitis in childhood and chronic obstructivepulmonary disease (COPD) in women in developing countries

3.1. Respiratory infections

Smoke inhalation alters several mechanisms of lung defences including the efficacy of both the mucociliary escalator and the macrophage function [21]. Exposureto biomass smoke has been clearly associated with an increase in the severity of respiratory infections in children, [30] a famous cause of disease and death in developingcountries. Furthermore, the risk of pneumonia in young children is increased by exposure tosolid fuels by a factor of 1.8.Several studies also found an increased risk of tuberculosisin those exposed to biomass stoves, although such studies are scarce and the results mixed. [31].Biomass smoke exposure is likely only one of the important mechanisms by which poverty increases the incidence of respiratory infections and tuberculosis.

3.1.1.Lower Respiratory Tract Infections

Young children living in households exposed to solid fuel (BMF) have a two to three times greater risk of developing acute lower respiratory tract infection (ALRI) compared with those living in households using cleaner fuels or suffering less exposure to smoke [32] In children under 5 years, the mortality attributable to ALRIs is estimated to be over 2 million deaths per year [33, 34, 35]. One relatively small cohort study in rural Kenya found that the amount of pollution a child is exposed to directly correlates with the risk of developing pneumonia [36] Many studies in emerging countries have reported on the relationship between publicity to indoor air pollution and acute lower respiratory infections [37,38] . The different studies on indoor air pollution from domestic biomass fuel are almostbalanced. Most of the studies show a significant increase in risk for unprotected young children living in house hold using unprocessed fuelin comparison with those living in households using cleaner fuels or being otherwise less exposed [32].

3.1.2.Upper Respiratory Tract Infections

Studies on the relationship between indoor airpollution and upper respiratory infections in children both from developed and [39, 40]and developingnations [41, 42] have not been able to demonstrate the relationship between the two. However, there is strong evidence that exposure to environmental tobacco smoke causes middle ear disease [43]. A hospitalcentred case-control study of children in rural New York state reported an adjusted odds ratio for otitis media, involving two or more separate episodes for exposure to wood burning stoves [44].

3.2. Chronic obstructive lung disease

BMF smoke is responsible for COPD in non-smoking women living in rural areas [45, 46, 15].In women from rural Turkey it is estimated that the fraction of COPD attributed to exposure to biomass smoke, after adjusting for possible confounding factors, is 23.1% [47]. Cigarette smoking rates remain relatively low in developing countries compared with Europe and the USA [48, 49]. However, in Mexico, women exposed to domestic BMF smoke develop COPD with clinical characteristics, quality of life and increased mortality similar in degree to that of tobacco smokers[50,51].Padmavati and co-workers[52,53] are of opinion to theconnection between exposure to indoor air pollutantsand chronic obstructive lung disease leading to chroniccorpulmonale.

Theprevious authors recognised this greateroccurrence of chronic corpulmonale in women as the women exposed to domestic air pollution as a resultof the burning of solid biomass fuels leading to chronicbronchitis and emphysema which result in chronic corpulmonale. Most of the Sequential studies in India established thesefindings [54,55].Numerous studies from other countries,including ones with cross-sectional and case-controldesigns, have reported on the association between exposureto biomass smoke and chronic bronchitis or chronicobstructive pulmonary disease[56,57,58,59,60,61,62] .

IV. CONCLUSION

IAP excessively affects women and children's respiratory health due to their functional exposure and spending more time indoors. Introduction of women and children in developing countries to IAP has significantly contributed to the global burden of disease. IAP isadaptable hazardhaving known interferences to moderate its effects. Other than solid fuel and SHS exposure, pollutants from other sources, yet to be explored, may play an important role in impacting on the respiratory health of children in developing countries. Household use of solid fuels is globally the most widespread source of indoor air pollution; solid fuels are widely used for cooking and home heating in developing countries. Globally, about 50% of all households and 90% of rural households use solid fuels (coal and biomass) as the main domestic source of energy, thus exposing approximately 50% of the world population-close to 3 billion people-to the harmful effects of these combustion products [63] In Mexico, about 27 million people, mostly

concentrated in rural indigenous communities, depend on biomass burning, particularly wood, for cooking and heating using traditional open fires. Compared with men, women and young children are affected to a greater extent because they spend more time in the kitchen or near the fire in the home [64].There is conclusive evidence that indoor air pollution is a substantial risk factor for acute lower respiratory infection (ALRI), chronic obstructive pulmonary disease (COPD), and lung cancer. Evaluation of the impact on ALRI of various types of intervention in different settings will need to draw on other sources as well, including risk of exposure, data on exposure differentials observed between various fuel and stove combinations [65] The adverse health effects of indoor air pollution are often exacerbated by lack of ventilation in homes using BMF and by the poor design of stoves that do not have flues or hoods to take smoke out of the living area. The burningeffectiveness of BMF is also very little, thus it producescomparativelygreatplains of yields of unfinishedburning, which are more injurious to health. The lower smoke output observed with these stoves has allowed health professionals to use them in trials as health interventions. However, systematic evaluations have shown that there are practical barriers to stove adoption [66].The exploitation of fossil fuels that are integral to modern living has been part of the fasttechnical, societal, and traditionalmodifications of the previous 250 years. Although such changes have brought about undeniable benefits, they have also contributed to the pollution of local and regional environments due to the release of a great number of chemicals. People living in industrialized countries have other exposures due to more energy-efficient houses built from a variety of new building materials, plus chemicals and pets, in addition to a more sedentary lifestyle spent mainly indoors. Thoughprevious studies evidenced for increase in indoor air pollution in India, and its relationship with both increased morbidity and mortality rate, we need furthertrainings to evaluate the exposure stages of indoor pollutants and to additionalsupport with the evidences for their relationship with conclusionsof different health problems. Simultaneously activeinvolvements, initially fromteaching to people, modification in fuel forms, appropriatescheming of stoves and homes, to a dedicated and strong-minded intersectoral managementfor upgradation of public health is the essentiality of present scenario. Fruitful prevention policies need healthyevidenceaffecting to the problem created from miscellaneous settings. Upcomingexploration is required in numerousparts. Almostmainpartscomprise quantification of diversified airimpurities, vigorousassessment of relationsamongst indoor pollutants and antagonistic respiratory health effects, hereditaryproneness to indoor pollutants and their oncogenic effects, influence on lungs, features and valuation of fruitful IAP decreasing involvements (e.g., cook stove and ventilation), traditionalobserves and actions that lead to a decrease or an increase in IAP and its exposure.

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