

Wood Smoke: Still a Serious Challenge to Public Health in Developing Countries

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Abstract: The sentiment that woodsmoke, being a natural substance, is benign to humans is still sometimes heard. Chronic indoor air pollution in developing countries accounts for 2.2–2.5 million deaths annually. Wood smoke generates about 200 chemicals and particulate matter that can cause a variety of health problems including various types of cancers. This review article discussed various ill effects of smoke and particulate matter on the health of children and adults.

Key words: Benign • Cancer • Smoke • Pollution

INTRODUCTION

When human for the first time migrate to temperate climate, they start building shelter and for the purpose of light, warmth and cooking indoor fire was used. Therefore, indoor air pollution can be traced to prehistoric times. In prehistoric caves, soot were discovered which indicates indoor air pollution. About 50 % of the total world's population and in developing countries approximately 90% of rural households still depends on unprocessed biomass fuels like crop residues, dung and wood. These are normally burnt in unwell functioning stoves or inside in open fires. As a result of these indoor pollution, children, women and mostly those peoples who are responsible for cooking are chronically exposed [1, 2]. In recent era, in modern societies wood burning devices are used which like natural fuel also create indoor pollution [3, 4]. Indoor air pollution in developing countries accounts for 2.2–2.5 million deaths annually [5]. The use of wood burning devices has exposed public to smoke pollutants generated during combustion. In wood smoke combustion, more than 200 chemicals are generated while its particulate matters are in inhalable size range [6]. Wood burning devices also contribute to outdoor air pollution [7, 8] and causes both acute and chronic ill effects in exposed humans [7, 9].

Tandoor: A Tandoor which is used for baking and cooking is a cylindrical in shape made of clay. Tandoor is used for cooking in many countries like Pakistan, Bangladesh, Burma, Afghanistan, Iran, Turkey and India. For Tandoor, charcoal and wood was traditionally used to generate heat for cooking and baking [10]. Various types of food can be cooked through Tandoor, such as Naan, Tandoori roti, Chicken tikka, Tandoori chicken etc. in various countries [10, 11].

Chemical Composition and Effects of Wood Smoke: Burning wood produces toxic particles in air. Wood smoke contains Particulate Matter (PM), dioxin, volatile organic compounds, nitrogen oxides and carbon monoxide. Some of the VOCs are nauseating, noxious and/or cancer causing. Main hazardous material to human health is PM present in smoke from indoors or outdoors. PM of the wood smoke contains, ashes, dust, gases and wood tars. Wood smoke also contained polycyclic aromatic hydrocarbons (PAHs), which contains several carcinogens for example benzopyrene. In wood smoke, the total quantity of toxic materials and its composition rely on how much the wood or other biomass is burned. This generally rely upon the appliances utilized for wood and other biomass burning. The amount of toxicants produce can be reduced using efficient burning appliances.

The size of the PM produced during combustion in air is lesser than 2.5 micron. These particles along with toxicants deep penetrated into the lungs. These toxicants can cause a wide range of disorders like asthma, bronchitis and cardiovascular disorders. Chronic exposure to wood smoke may cause chronic obstructive lung disease, chronic bronchitis, increased risks of cancer and cardiovascular disease. There is also the penetration of smoke from backrey yard fires to nearby homes through air, increasing the risk of exposure to toxicants present in air [12].

Wood smoke is a natural substance and burning stoves, fire places as well as wild land and agriculture fires emit significant qualities of known health damaging pollutants, including several carcinogenic compounds [13]. Highly exposures to air pollutants in developing countries occur in houses where mostly wood fuel and solid fuel is used for cooking. A large part of world population is highly exposed to an increase level of indoor air pollutants produced from wood stoves [14].

Half of the world population is exposed to high amount of solid fuel smoke (coal and biomass) which is produced from fires, mainly in the developing countries. Domestic pollution is also at risk because most of the people spend their time indoor. Solid fuel smoke produced high toxins found in tobacco smoke and also been associated with many types of diseases, e.g. acute respiratory infections [10], lung cancer and obstructive pulmonary diseases in woman [15].

Effects of Wood Smoke on Cardiovascular System, Inflammation, Coagulation Factor and Oxidative Stress:

There is cardiovascular, coronary artery diseases, cerebrovascular diseases and venous thrombo-embolism in people exposed to particulate matter and is frequently found among older people with diabetes and previous cardiovascular conditions [16]. The cardiovascular morbidity and mortality is known to increase by particulate air pollution due to effects on inflammation, coagulation factors and oxidative stress which leads to increasing risk of coronary events and atherosclerosis [17]. According to latest studies, tens of thousands of death related to cardiovascular system occurs each year and the mechanism of its mortality is unknown [18]. Nemmar *et al.* [19] reported that the ultra-fine fraction which comes from burning of fossil fuels is very toxic because it causes coagulation cascade, platelet function and subsequent development of atherosclerosis and thrombosis. Similarly, Adverse cardiovascular events

including hospital admission with angina, myocardial infarction and heart failure and even death to prolonged nanoparticle exposure as it affects blood pressure, vascular tone, heart rate, blood coagulability and the progression of atherosclerosis [20, 21]. The ultra-fine particles are directly translocated into the circulation and reach to vasculature and heart, causing decrease coronary flow and cardiac contractility and cardiac arrhythmias [17]. Buturak *et al.* [22] traced higher serum total cholesterol and LDL levels in the study group as compared to control group while evaluating the effect of chronic biomass fuel (BMF) smoke exposure on peripheral endothelial functions. It was concluded that chronic BMF smoke exposure may be a risk factor for the development of endothelial dysfunction. Endothelial dysfunction is an early event in atherosclerosis and there is a close relation between coronary artery disease (CAD) and peripheral endothelial dysfunction, which reflects the functional impairment of the endothelium before morphological changes can be detected. It has been concluded that wood smoke elevate cholesterol level and, all those people will be at more risk to atherosclerosis and vascular problems which are regularly exposed to wood smoke.

Blood Pressure: The chimney stove was associated with low blood pressure after adjusting for time of day, day of week, season, apparent temperature, second hand tobacco smoke, body mass index and age [23]. Similar findings were also concluded by Simkhovich *et al.*, [21] that air pollutant when inhale, affects blood pressure.

Blood Profile: Inhalation of some component of PM leads to sequestration of red cells in the circulation. They propose that an action of such particles either on lung endothelial cells or on erythrocytes themselves may be responsible for changing red cell adhesiveness [24]. Nabi *et al.* [10] investigated that chronic wood smoke exposure in Tandoor occupants significantly increases RBCs, hemoglobin, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, neutrophils, eosinophil, lymphocytes, monocytes, total leukocytes count, platelets but decrease hematocrit concentrations.

Blood Glucose Level: After smoke inhalation it was found that, blood glucose level rises as compared to control group and the elevated blood glucose depend on the exposure time. This increased blood glucose level may be due to the mobilization of catecholamines and the

stimulation of cortisol production. Smoking lowers the level of adiponectin hormone which has a role in maintaining a normal sugar blood count and also checks other metabolic problems. The low level of adiponectin hormone leads to obesity, increased insulin resistant and eventually type II diabetes. During pregnancy Montgomery [26] found that smoking can cause gestational diabetes and even diabetes in their offspring in later life.

SGPT Level: Inhalation of wood smoke in Tandoorsignificantly raises plasma SGPT level as compared to control group [10]. Similar findings were also reported by Loh *et al.* [27] who stated that serum SGPT elevated about 1.5 fold the normal limitby the inhalation of smoke (having high concentration of Hexachloroethane-zinc oxide, zinc chloride, hydro carbons and chlorinated vapors).

Respiratory System: Exposure to wood smoke leads to irritation of the mucous and also has physiological and neurological effects in human[28]. It has been suggested that wood smoke and poverty causes reduced lung function in rural Africans and that chronic obstructive pulmonary diseases (COPD) is common in this population, but the use of charcoal in this population may be relative protective [29]. Kunzli *et al.* [30] examined the people in Southern California exposed to a heavy smoke of wildfires of several communities. The irritation in throats, eyes and nose, cold, asthma attacks, wheezing and cough were linked with individually reported exposure differences within communities. Similarly, wood smoke inhalation in adults can also leads to chronic bronchitis [31],fibrosis,chronic interstitial pneumonitis, [32], pulmonary arterial hypertension,interstitial lung disease, [33], abnormal pulmonary immune defense mechanisms [32, 34].

Children, women and the elderly peoples who kept indoors are at high risk of both upper and lower respiratory tract infection. Women who spend long time in cooking in poorly ventilated homes develop chronic obstructive lung disease (COPD), asthma, respiratory tract infections, including tuberculosis and lung cancer. It has been argued that exposure to biomass fuel smoke is a bigger risk factor for COPD than tobacco smoking[35]. Minnesota Pollution Control Agency,[36] have also given same report that, both long term and short term wood smoke exposure causes sinuses, throat, lungs and eyes irritation. It was also found that it increases severity of

present lung diseases such as chronic bronchitis, chronic obstructive lung disease, pneumonia, emphysema and asthma.

Chronic wood smoke exposure and the incidence of pulmonary tuberculosis are linked as reported by Mishra [37]. Peoples living in households burning biomass reported tuberculosis more frequently than persons using cleaner fuels. Similarly, in India about 59% rural cases and 23% urban cases of tuberculosisconfirmed the association between wood smoke and incidence of tuberculosis.Chronic wood smoke exposure reduces lung resistance by interfering lung mucociliary defenses [38], decreases cellular immunity, antibody production, local bronchial immunity and increased susceptibility to infection and cancer [39].

Effects of Wood Smoke during Pregnancy: Chronic exposure of pregnant women to wood smoke from chimney stove is associated with Low Birth Weight (LBW) [40].

Wood Smoke and Cancer: Mutagens cause mutations in cells and cause cancer. Motor vehicles and wood smoke also cause mutation. These two sources are also major contributions to the human cancer risk from air pollution [41, 42].Biomass smoke exposure has been associated as a causative factor for nasopharyngeal carcinoma [43]. In Brazil, oral cancer was linked with the use of wood stoves, alcohol and tobacco [44]. Similarly, 784 cases of laryngeal, pharyngeal and oral cancer were associated with wood smoke in South America [45].

Cataract: Persistent exposure to wood and dung smoke can cause eye irritations [46], cataract [1], partial or complete blindness [47]. Similarly, animal studies have shown that chronic wood smoke exposure in rats can cause lens discoloration,opacity and particles of debris by absorbing and accumulating toxins that leads to oxidation [48].

Reproduction: Many organic compounds such as, aliphatic hydrocarbons,aldehydes, quinines,heterocyclic organic compounds and polycyclic aromatic hydrocarbons are adsorbed in the carbon core ofsmoke particles [48]. These particles after entering into the atmosphere, have negative effect on our reproductive system when enter into our body throughintestinal tract, lungs and skin [49]. Smoke particles contained substances having anti-androgenic, anti-estrogenic and estrogenic

properties. In mice it also reduces, number of Sertoli cells, causes degeneration of Leydig cells and ultimately sperm production when exposed to smoke particles during fetal life [50]. In human, chronic exposure to wood smoke reduces plasma testosterone significantly, which ultimately leads to low libido, erection problems, infertility, decreased frequency for shaving and absent morning and nocturnal erection [51].

Wood Smoke and Pakistan: In Pakistan, about 70% of the population live in rural areas [52]. In Pakistan, about, 94% of households in rural areas and 58% in urban areas depend on biomass fuels. All of these solid fuels have low combustion efficiency. Low combustion efficiency of the biomass fuels, leads to incomplete burning which produces a lot of health deteriorating substances. Indoor air pollution is responsible for forty million cases of acute respiratory diseases and 28,000 deaths a year. It places a significant economic burden on Pakistan with an annual cost of 1% of gross domestic product (GDP).

Conclusions and Recommendations: Wood smoke emission is a very common problem throughout the world. It has been found that wood smoke has deleterious effects on the persistently exposed people. Persistent wood smoke exposure leads to hypertension, lungs infection, dry cough, chest pain and physical weakness. Due to these hazardous effects the use of chimney stoves and exhausts should be encouraged. During cooking time masks must be used and minimum smoke producing woods like dry wood should be selected for cooking. The printed as well as electronic media should aware the people from the hazardous effects of wood smoke generating during cooking. Government should supply gas to the areas where wood is commonly used for cooking. The environmental protection agencies should give emphasis on burning devices to regulate its manufacturing to avoid the emission of huge amount of smoke. Seminars should be arranged in educational intuitions.

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