

# INDOOR AIR QUALITY INDEX AND CHRONIC HEALTH DISEASE: A PILOT STUDY

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## Abstract

Approximately about 2 million premature deaths per year in developing countries by indoor pollution this is estimated by WHO (2006). Indoor activities (cooking, smoking, incense, mosquitoes coil and others), building characteristics and outdoor climatic conditions have affected indoor air quality environment. Especially young and unemployed people spend about 90% of their times in indoor environment so, air quality index (AQI) is now becomes the essential task for determine the quality of indoor homes. Indoor air quality index concern to pollutant concentration.  $AQI = 1/3 [SPM/SSPM + SO_2/SSO_2 + NO_x/SNO_x] \times 100$ . More will be the value of AQI more hazardous will be the quality. One of the most important parameter for indoor air quality is particulate matter (PM<sub>2.5</sub>) and due to long exposure to particulate matters may lead to mortality. Women and children are mainly affected by indoor pollution because they spend more time in homes as compare to others. So, increased the respiratory symptoms, decreased the lung function, increased lung cancer incidence, cardiovascular mortality and accelerated arterosclerosis and vascular inflammation all these ill effects mainly observed in women's and infants.

**Keywords:** Indoor air quality, air quality index, vulnerable group, indoor pollution, acute respiratory infection.

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## 1. INTRODUCTION

After rapid industrialization and urbanization indoor air quality becomes the challenge for all the developing and developed countries. In developing countries basically in rural areas, due to inefficient open fires, rural areas are highly exposed to high concentration of solid fuel smoke that is produced by burning of biomass and coal. Cow dung, wood, liquefied petroleum gas (LPG) and propane natural gas (PNG) kerosene are the main source for cooking purposes (Gautum et al.,2011 ). But in urban areas, there are other reasons like the poor sanitation, generation of solid wastes, open landfilling burning of solid waste, inadequate housing, lack of awareness regarding toxicity of air pollutants emitting from various sources and water supply causes the ill health effect of women and children (Bruce et. al.,2000). Combustion of biomass fuel in poorly ventilated kitchen leads to release of high concentration of respirable particulates, gases like CO, SO<sub>2</sub>, NO<sub>x</sub> and toxic compounds benzene, formaldehyde and polycyclic aromatic compounds such as benzo (a) pyrene.

Indoor air quality environment is interacted and affected by the local outdoor air, specific building characteristics and indoor activities (Stranger et al.,2007). Indoor activities and poor ventilation qualities responsible for high level of indoor RSPM and PAHs in rural homes in india (Gadhkari 2008). Poor indoor air quality has been ranked as one of greatest health risk concern because people spends a substantial

amount of time in indoor environment and indoor air concentrations of pollutants can be greatest than those found outdoors (Soysal and Demiral,2007). Indoor pollutants emissions originate not only from building materials or furnishing, but also from common household activities such as cooking, smoking and burning of incense and candles (Singh et al.,2012) and also from various consumer products which people use at their homes in their day to day activities.

## 2. INDOOR AIR QUALITY AND AIR QUALITY INDEX (AQI)

ASHRAE define the air in which there are no known contaminants at harmful concentrations and where the substantial majority (80% or more) of the people exposed, do not express dissatisfaction. Indoor pollutant affects the quality of homes; there is an also indoor air quality standard that reflects quality of homes. AQI is calculated for four major air pollutants regulated by the Clean Air Act- Ground level Ozone, Particulate Pollution, Carbon Monoxide ,Sulfur dioxide .

**Air Quality Index (AQI):** The average of the sum of the ratios of three major pollutant concentrations to their respective air quality standard were obtained. The average was then multiplied by 100 to get the index [10].

$$AQI = 1/3 [SPM/SSPM + SO_2/SSO_2 + NO_x/SNO_x] \times 100$$

Where  $S_{SPM}$ ,  $S_{SO_2}$  and  $S_{NO_x}$  represent the ambient air quality standards for SPM, SO<sub>2</sub> and NO<sub>x</sub>.

For each of these pollutants, EPA has established national air quality standards to protect public health. EPA is currently reviewing the national air quality standard for nitrogen dioxide. EPA (Environment Protection Agency) have recommended the scale to detect Air quality index . AQI starts from 0-500. More will be the value of AQI more unhealthy air and serious health effects.

QUALITY	RANGE	STATUS OF AIR QUALITY
Good	0-50	Air quality is satisfactory and poses little or no health risk.
Moderate	51-100	Range may pose a moderate health concern for a very small number of individuals
Unhealthy for sensitive gr.	101-150	Members of sensitive groups may experience health effects, but the general public is unlikely to be affected
Unhealthy	151-200	Members of sensitive groups may experience health effects, but the general public is unlikely to be affected
Very Unhealthy	201-300	Trigger a health alert, meaning everyone may experience more serious health effects.
Hazardous	Over 300	Trigger health warnings of emergency conditions. The entire population is even more likely to be affected by serious health effect.

Refrence:www.sim-air.org

### 3. FACTORS EFFECT INDOOR AIR QUALITY

**Indoor Combustion-**Combustion is the most important sources of air pollution. Indoor combustion for cooking, lighting and heating has contributing to air pollution. Fuel combustion in kitchens is the most dominant source of indoor air pollution and can cause severe impact on health and environment. Indoor air pollution from solid fuels as one of top leading causes of global mortality and disease (Lopez et al.,2006). This based on the use of biomass and coal as cooking fuels in rural parts of developing countries. Unvented or incompletely vented combustion also occur to a substantial extent in economically developed countries. Such combustion has a demonstrated impact on indoor pollutant concentration and exposures.

#### 3.1 Cooking

In united state and other developed countries, cooking causes air pollutant exposures that have potential public health significance. For example, the use of natural gas as a cooking

fuel is associated with elevated indoor exposures to nitrogen dioxide, a byproduct of the combustion process. Exposure to ultrafine particles can be substantially increased by emissions from cooking ((Bhangar et al.,2011) .One half of the world’s population is exposed to high concentrations of solid fuel smoke (biomass and coal) that are produced by inefficient open fires, mainly in the rural areas of developing countries. Concentrations of particulate matter in kitchens increase to the range of milligrams per cubic meter during cooking. Emissions of ultrafine particles are caused not only by combustion of cooking fuel but may also result from high temperatures associated with electric cooking elements (Wallace et al.,2008). Earlier studies also reported the emission of great concentrations of particulate matters from small scale biomass combustion process and their adverse health effects (Bologo et al., 2012; Gordon et al.,2007) . Studies have shown that PM10 concentrations range from 500-2000  $\mu\text{gm}^3$  during cooking sessions in typical Indian households, which is several times the USEPA, standard of 24-hour average of 150 $\mu\text{gm}$  (Balakrishnan et al.,2002). Particles with diameter below 10microns (PM10) and particularly those less than 2.5 microns (PM2.5) are small enough to penetrate deeply into the lungs and appears to have greatest potential for damaging the health. There are numbers of report that depends on questionnaire for study the biomass smoke and its exposure to health. (Mahesh et al.,2013 ; Hashmi et al.,2013).

#### 3.2 Smoking

Indoor smoking adversely affects indoor air quality and public health. Smoking indoors has a strong influence on indoor levels of the particulate matter (Nazaroff and Klepeis 2004, Hyland et al 2008). Environmental tobacco smoke is also an important cause of environmental exposure to certain hazardous air pollutants, including acrylonitrile, 1,3-butadiene, acetaldehyde, acrolein and formaldehyde (Nazaroff and Singh 2004). Evidence indicates that several severe adverse health impacts are associated with ETS exposure, including acute myocardial infraction (Lightwood and Glantz 2009), lung cancer and a host of respiratory health problems in children . Singh et al (2010) have estimated that 7.6% of children in US are exposed to ETS in their own homes. Exposure to ETS occur not only in within the residence in which smoking occurs, but also, in the case of multifamily dwelling, in neighboring units (Bohac et al 2011).

#### 3.3 Space Heating

Combustion for space heating is sometimes associated with substantial pollutant emission; especially because of relatively large amounts of fuel used for home heating as compared. Household use of kerosene heaters and fireplaces for heating was found to be associated with respiratory symptoms in nonsmoking women. Colberk (2010) studied the particulate matter concentration increased in indoor air in winter when

occupants burn wood and coal to keep them warm, concentration of particulate matter depends on biomass fuel used, duration of cooking, degree of incomplete combustion and also ventilation.

### 3.4 Incense and Mosquitoes Coils

Indoor air pollution in dwelling areas is mainly due to emission from cooking, smoking, burning of mosquito's coils, cigarettes, incense sticks and candles. By smoking of a single cigarette about 10,000 and 40,000 mg particulate matter are inhaled and by burning of one mosquito coil releases the same amount of PM<sub>2.5</sub> mass as burning of 75-137 cigarettes. Mosquito coil also widely used as a repellent in various Asian countries including China, India, Malaysia, Korea, Japan and Thailand. Major active components in mosquito coils are pyrethroids such as d-allethrin, esbiothrin, transfluthrin and metofluthrin. Liu et al., 2003 studied that all particles emitted from burning mosquito coils were fine, < 1µm in diameter most particles were in size range of 0.01-0.1µm and 0.2-0.3µm. Burning of incense, candles and mosquito coils is generally an incomplete combustion process. It is well known that it produces various kinds of air pollutants including particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO<sub>x</sub>), volatile organic compounds (VOCs) and toxic metals. Smoke released from these activities contains significant amount of pollutant like Particulate Matter (PM), Polycyclic aromatic hydrocarbons (PAHs), Carbon monoxide (CO) and other toxic gases which are identified as potential carcinogens (Singh et al., 2010). In India and other countries indoor pollution is also with incense, candles and mosquito coils. The combustion of incense, wood, cigarette and candles is important or ever major sources of residential indoor particulate matter especially in the 2.5µm size. The burning of incense could generate large quantities of PM, carcinogenic PAHs (Chiang et al., 2006) and CO.

## 4. HEALTH IMPACTS OF INDOOR AIR POLLUTION

Both indoor and outdoor pollution cause major environmental health problems in developed and developing countries. It comes from sources of dust, gases and smoke, and is generated mainly by human activities but also naturally. While the problem regarding outdoor air pollution has been well publicized for several decades, it is indoor air pollution that is causing the most recent concerns for obvious reasons. Lopez et al (2006) ranked 'indoor air pollution from solid fuels as one of the top ten leading causes of global mortality and diseases. Incense burning almost doubles the risk of developing squamous cell upper respiratory tract carcinomas including nasal/sinus, tongue, mouth and laryngeal. There was an increased risk both in smokers and in nonsmokers, pointing to an independent effect of incense smoke. Indoor air pollution is the risk factor for number of diseases and poor health of society. Several severe adverse health impacts are

associated with ETS (Environment Tobacco Smoke) exposure, including acute myocardial infarction (Lightwood and Glantz 2009), lung cancer, and a host of respiratory health problems in children and asthma in nurseries and primary school children (Sousa et al., 2012). Exposure to ETS occurs not only within the residence in which smoking occurs, but also, in the case of multifamily dwelling, in neighboring units (Bohac et al 2011). Acute respiratory tract infection (ARI), chronic obstructive pulmonary disease (COPD), low birth weight, cataract, blindness are more common in poor urban people of these countries. Women and children spend most of their time indoors and are majorly affected.

## 5. WOMEN AND CHILDREN HEALTH

It is also estimated that 3.7 percent of overall burden of disease is only due to indoor smoke (WHO, 2005) and indoor air pollution is also responsible for 2 million deaths in developing countries and 4 percent of global burden of diseases (Bruce et al., 2000). Women are the primary cooks and care takers for children in nearly all cultures, so their children are prone to receive the greatest exposure to the smoke from solid fuel combustion. The exposure leads to higher risks for women as well as children (Dasgupta et al., 2004; WHO, 2007). Several researchers (Mirza et al., 2008), (Akhtar et al., 2007), (Lakshmi Singh et al., 2011) found a linkage between indoor smoke exposure and increase the risk of respiratory tract infections and lung cancer among housewives (Dabral et al., 2012). In India, usually women spend their 3 to 7 hours near the stove for cooking and highly exposed during cooking (Singh and Parveen, 2010). About 50% of deaths from chronic obstructive pulmonary disease (COPD) in developing countries are attributed to exposure to biomass fuel smoke and 75% of these deaths are in women. Studies both in India and other countries have a significant association with symptoms such as chronic cough, chronic phlegm and chronic respiratory disease such as chronic bronchitis, asthma, cor pulmonale and to chronic respiratory failure (Mahesh et al., 2013) and adverse pregnancy outcomes (Behera et al., 2010). In India, prematurity and low birth weight (LBW) were the major cause of mortality among the neonates and increase in acute lower respiratory infection (ALRI) was major cause of mortality.

## CONCLUSIONS

Increasing the standard of living, indoor air quality is affected and women's are the most vulnerable group which is affected by number of diseases. There are number of pollutants released by cooking, burning and other household activities. There is now need to address the problems differentially. There are number of health problems like acute respiratory tract infection (ARI), chronic obstructive pulmonary disease (COPD), low birth weight, cataract, blindness are more common in poor urban people of countries for which the available evidence is very limited. Efforts should also be made to support emerging

exposure-response relationships; particularly for common and serious health problems. Research should pay attention to the valid outcomes such as acute lower respiratory infections.

## REMEDIES

Indoor air pollution has a major impact on health. Rapid urbanization, globalization and increasing population crisis but there are stress on the environment. So, strategic actions should be taken by all sectors otherwise problem worst the health of humans and problem will be hardest on the poor and vulnerable sections of population. There is need to address the problems differently. There are ways to iron out the situation and make a women's time in kitchen healthy and pleasurable. These interventions can occur on many fronts which include: clean and efficient cooking fuel (LPG, electricity) , Improving cooking devices (stoves) providing more heat, less smoke and less fuel consumption, Improving living environment (ventilation through doors and windows, separate kitchen), Behavioral change (spending less time in kitchen, fuel drying, using pot lids, proper maintenance of stoves, keeping children away from smoke) .Awareness towards the ill health effects of indoor air pollution and make the standards for indoor pollutants.

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