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Indoor Aerosols: A Serious Threat for Human Health

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An air pollutant includes the form of gas or aerosol that may be available as solid, liquid, radioactive and bioaerosol. Air pollution has affected all urban areas in devolving countries [1]. It has been estimated that if there is no intervention in air pollution control, the mortality number increases to 6.6 million deaths by 2050, especially in Asia [1]. Indoor aerosols are a global issue because of their impacts on public health [2]. Indoor air pollutants are one of the air pollution constituents and could be generated from indoor or outdoor transportation [3]. At first, attention to indoor air pollution performed in the 1960s, when the preliminary measurements of indoor pollutant concentrations were made [4]. It has been estimated that about 85% of indoor dust comes from outdoor, such as fossil fuel burning, crustal materials, and road dusts [5]. People in developed countries spend approximately 90% of their time indoors. This percentage rises even higher for sub-populations such as infants and young children, the elderly, and people living with disabilities. Given this high percentage that most people spend indoors, it is important to recognize that human exposure to pollutants occurs not only outside of buildings but also inside them [6]. This study aimed to find the relationship between indoor air pollutants and their contributions rates on the public health especially in developing countries. Eventually, the obtained evidence caused to understand the critical role of indoor environments in driving exposures to inhaler pollutants and provided executive actions to control them in vulnerable groups including; infants, children, and adults, respectively [4].

What is the source of indoor air pollution?

Household dust is a heterogeneous mixture of gases, vapors, and particles that originate from indoor and outdoor sources. Figure 1 shows the indoor air pollutants and their relationship. As it is revealed in Fig.1 household air pollutants can origin from internal or external sources. External sources, such as soil, vehicle exhaust emissions,

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agricultural, industrial emission, and natural aerosols [2, 7] . while internal sources are including chemical, building and construction materials, furnishing, smoking, cooking cleaners, emissions from building furnishing, and etc [2, 7, 8] . Sharim et al. conducted a study (2016) of loading rate of dust in residential houses of arid areas. The results showed that in arid and semi-arid areas, low traffic density, lake of major industries and infrequent dust storms had important role in decreasing and controlling of indoor air pollutants [2] .

In the Middle East, dust or soil particles are the major sources of the external sources produced naturally or manually with hazardous chemicals and settled down in indoor environments [2] . Furthermore, internal dusts are partly due to biological agents. Dogs and household insects can affect the type of microbes found inside the house [9] .

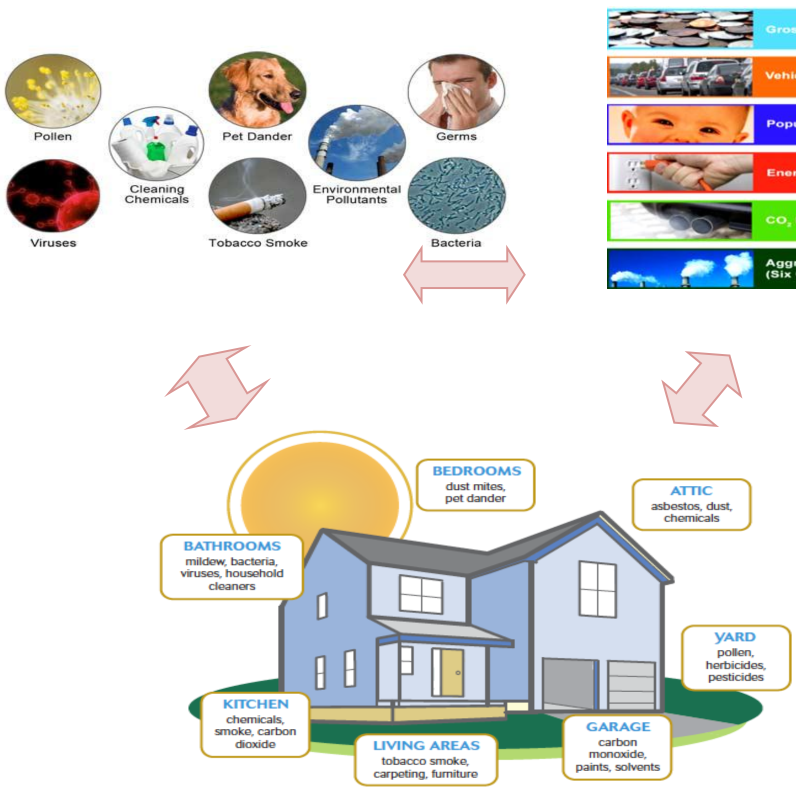

Figure 1: Indoor and outdoor air pollutants origins and relationship [10]

Is there a relation between the dust and health problem types?

Air pollution specifically in developing countries is a significant health determinant leading to an increased risk of heart and pulmonary diseases [1] . Generally, fine particles less than 2.5 µm affect the respiratory health, while more than 2.5 µm are removed by upper respiratory systems [11] . Therefore, the management and control of these particles are necessary and unavoidable.

These particle concentrations are variables depending to ventilation, building design and other parameters. Indoor microorganisms may be influenced by outdoor conditions. Some of these microbes have negative effects on human health, such as Staphylococcus aureus or others serving as allergic asthma [9] . One of the most hazardous detected in house dust is heavy metals. Their adverse effects on human are including; disorder on human diseases, multiple organ damages, and etc [2, 6] . Indoor air pollution is among the top five environmental health risks [12] . The health risks posed by exposure to contaminants indoors are of significant concern [13] . Researchers highlighted 45 toxic chemicals in indoor dust, 10 of which were present in 90% or more of the dust samples, including flame retardants, fragrances, and phenols. The flame retardant Tris (1,3-dichloroisopropyl) phosphate (TDCIPP) is known to be cancer-causing. Other toxic substances found in almost all of dust samples, including chemicals known as phthalates that have been linked to developmental problems in babies, hormone disruption, and are also thought to affect the reproductive system [14] . Li et al. in their study extracted seven phthalates from indoor dust in the north of China. Di-(2-ethylhexyl) phthalate (DEHP) was the most abundant phthalate in house dust. The predicted results of CR and RQ of DEHP suggested that DEHP could pose a health risk through intake of indoor dust [15] . Neisi et al. in their study investigated the concentration of heavy metals in household dust and their health risks on children living in different areas of Ahvaz city during November 2013 to October 2014 in Iran. They found that household dust of Ahvaz city would probably have a significant potential to cause cancer in most exposed children [16] . Maertens et al. examined organic extracts of sieved vacuum cleaner dust from 51 homes for the presence of 13 polycyclic aromatic hydrocarbons (PAHs). PAHs are one of the most contaminants that emitted to the atmosphere. Their anthropogenic origins are including combustion of solid fuels, manufacturing, food processing, smoking and etc. The amount of PAHs in the house dust depends on many factors such as the level of particulate contamination of air. For example, the presence of smoker, the method of food preparation and etc [17] .

A risk assessment was conducted to evaluate the excess cancer risks posed to preschool aged children who were exposed to PAHs in settled house dust (SHD). The assessment revealed that exposure to PAHs at levels found in 90% of the houses (< 40 µg g^{-1}) would result in excess cancer risks that are considered acceptable (i.e., 1–100 × 10^{-6}). However, exposure to higher levels of PAHs found in five homes yielded risks that could be higher than 1×10^{-4}. Liu et al. investigated the arsenic concentration and characterized health risks due to arsenic (As) exposure via soil and indoor dust in rural and urban areas of Hubei province within central China. The total arsenic content in indoor dust samples was 1.78–2.60 times measured in soil samples. The results suggest no non-carcinogenic health risks (HQ < 1) or acceptable carcinogenic health risks ($1 \times 10^{-6} < CR < 1 \times 10^{-4}$) in all studied locations. Indoor activities comprised between 64.0% and 92.7% of the total health risk incurred during daily indoor and outdoor activities. The HQ and CR values for children in urban areas were 1.59–1.95 times more than those in rural areas [18] ; therefore, dust was not just a minor problem. There are some ways to get rid houses of these nasty chemicals and keep families as healthy as possible.

These findings can be used to improve population health by informing future exposure assessment and epidemiologic studies of chemical mixtures as well as individual and regulatory exposure reduction strategies. Considering the above information, it is obvious that monitoring of human environment regarding the house dust is one of the essential parts of environmental studies. However, the indoor decay rate of pollutants depends on the pollutant properties and home characterizations such as air exchange or/ and weather conditions.

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