

# **INDOOR AIR POLLUTION (Literature Review Study)**

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## Abstract

Indoor air pollution (IAP) is one of the most serious threats to human health, which lead to millions of deaths each year, so it is very essential to understand its causes, concentrations, sources, and impact on health in a purpose to put an effective strategies for the control of it, and in this study we provide a critical review of literature about IAP and indoor air pollutants including their emissions, health effects, and other environmental concerns related to it, in the first chapter we highlight the general strategy of the study, and in chapter two we present a complete review of literature about the study topic, finally in chapter three we point the findings of the study in addition of the suggested recommendations, and the last chapter includes the used references.

**Keywords:** Indoor Air Pollution, Indoor air pollutants, health impact, sources, causes, indoor air quality.

## المخلص

يعد تلوث الهواء الداخلي (IAP) أحد أخطر التهديدات لصحة الإنسان، والذي يؤدي إلى ملايين الوفيات كل عام ، لذلك من الضروري جداً فهم أسبابه وتركيزاته ومصادره وتأثيره على الصحة بغرض وضع استراتيجيات فعالة للسيطرة عليه ، وفي هذه الدراسة نقدم مراجعة نقدية للأدبيات حول تلوث الهواء الداخلي وملوثات الهواء الداخلي بما في ذلك انبعاثاتها وتأثيراتها الصحية وغيرها من الاهتمامات البيئية المتعلقة بها ، في الفصل الأول نسلط الضوء على الاستراتيجية العامة لـ الدراسة، وفي الفصل الثاني نقدم مراجعة كاملة للأدبيات حول موضوع الدراسة ، وأخيراً في الفصل الثالث نشير إلى نتائج الدراسة بالإضافة إلى التوصيات المقترحة.

**الكلمات المفتاحية:** تلوث الهواء الداخلي، ملوثات الهواء الداخلي، التأثير الصحي، المصادر، الأسباب، جودة الهواء الداخلي.

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## CHAPTER ONE: INTRODUCTION

### 1. Introduction:

Since the last decades, many efforts have been made in order to protect people from harmful effects of outdoor pollutants, such as increasing the number of air monitoring stations which are put in strategic areas to provide information about outdoor pollutant concentrations to which people are exposed. However, people usually spend about 80-90% of their time in different indoor environments such as: offices, homes, restaurants, etc. And the quality of indoor air is considered as one of the most important factors that influence people's health, and the quality of this air can be determined by different parameters such as: chemical emissions, physical parameters, and biological agents. It is a common thought between people that indoor air is safe from harmful agents or pollutants. However recent and previous studies and scientific evidence have shown that indoor air at houses can be more dangerous and harmful than outdoor air of the most industrialized cities. (WHO, 2006). Also, people who spend most of their time in homes may be chronically exposed to indoor pollution. (Perfetti & Rodgman, 2008). Indoor air pollution has a longer history than it is usually believed by people. And although attention to indoor air quality has been rising since the early twentieth century, the scientific interest in these cases was low prior to 1970. ( Hamanaka R.B., et, al, 2018)

Considering the importance of the study topic, this study is dedicated to discuss the indoor air pollutants, their main sources, causes of indoor air pollution, its health impacts and some suggested solutions from the previous and recent studies about the study topic to reduce exposure to indoor air pollution.

## 1.1 Study Problem Statement & Questions

### 1.1.1 Statement Of Problem:

The importance of the study lies on the danger of the indoor air pollution as indoor air pollutants may include various types of pollutants that can affect the health status of residents, as they contain volatile organic compounds, particulate matter and airborne allergens, and this huge complexity which present in indoor air pollution emissions and sources poses a main challenge in predicting personal exposure, and this problem can really damage the health level of population which lead to the reduction of health level and the spread of several disease.

### 1.1.2 Study questions

The problem of the study can be determined throughout the study main question which is:

**What are the serious impacts of indoor air pollutants on health and environment?**

From the main question, a set of sub-questions emerges as the following:

- ❖ What are the different sources and types of indoor air pollutants?
- ❖ What are the real mechanisms of indoor air pollution?
- ❖ How can we reduce the effect of indoor air pollutants?

## 1.2 Importance Of The Study

The importance of the study lies in the complete presentation of the study topic " Indoor air pollutants " and its types, sources, and impacts. Which can benefit the reader and specialized people on how they can be aware of this type of pollution and how they can avoid it effectively, which lead in turn to increase the level of health status within a country.

## 1.3 Study Objectives

The study mainly focuses on investigating the impact of indoor air pollutants on health and environment and how it can be reduced or either prevented, while the desired objectives of the study are:

- ✓ Investigating the sources, types, and causes of indoor air pollutants.
- ✓ To investigate the possible harmful effects of indoor air pollutants.
- ✓ To suggest a series of effective solutions in order to prevent indoor air pollution.

## 1.4 Study Approach

In this study we relied on the descriptive approach through extrapolating and analyzing the studies, books, and periodicals which are related to the study topic in order to identify the theoretical basis of indoor air pollutants and other various topics arise from it.

## CHAPTER TWO: REVIEW OF LITERATURER

### 2. Overview

In this chapter we provide theoretical information about the study topic which is present in the other studies and scholarly articles that discuss the same topic. The mentioned studies and articles shed light on indoor air pollutants and pollution, mainly its causes, effects, sources, types, and ways to avoid or reduce it.

#### 2.1 Indoor Air Pollution

Indoor air pollution (IAP) is the existence of pollutants, such as particulate matter (PM), volatile organic compounds (VOCs), physical chemicals and biological agents. Which can have a negative impact on human health, so it is very important to identify the main sources of IAP and put the suitable strategies to control indoor air pollution as one of the responsible factors for the death of 3.8 million people annually. (Young C.J., et, al, 2019)

IAP can be present inside houses, buildings in which occupants activities such as: smoking, use of consumer products, cooking, use of electronic machines, or emission from building materials are done. (Hromadka J., et, al, 2017)

IAP components can differ according to the sources, ventilation, conditions, and emission rates. (Argunhan Z.,et, al, 2018)

#### 2.2 Definition Of Indoor Air Pollutants:

Indoor air pollutants are factors which are released due to various indoor activities such as: cosmetics, heating, cooking, cleaning, and applied types of wall paints, etc. Also these pollutants are about 10 to 20 times higher than health guidelines for typical urban outdoor concentrations. (Yu K.-P, et, al, 2015)

## **2.2 Indoor Air Pollution Sources And Causes:**

Indoor air pollution is a potential health risk in developing and developed countries. In developed countries, the origins of indoor air pollutants include the environmental tobacco smoke, and the combustion by products such as: carbon monoxide, nitrogen dioxide, and particulate matter. (Salonen H.,et, al, 2018)

Infectious agents, biological agents, immunological agents, and allergens are other important causes for the human health impact of indoor air pollution. (Zhang X., et, al, 2017)

Furniture, construction materials and consumer products may cause dangerous exposures to semivolatile and volatile compounds such as: aldehydes, formaldehydes, naphthalene, benzen, tetrachloroethylene, and acrolein. One of the other dangerous agents is radon that can emanate from the soil and then penetrate homes through breaks or cracks and expose the building occupants to the radioactive progeny. (Okubo M., et, al, 2020) And it is important to note that indoor air pollution is responsible for approximately 2 million deaths in Asia and Sub-saharan Africa, and to control this concern we need strong interventions or developments of a modern technological and behavioral type in order to mitigate exposure and face the negative health impact of indoor air pollution. (Koivisto A.J., et, al, 2019)

### **2.2.1 Pollutants arise from different activities such as**

- Smoking: (pipe, cigar, or cigarette)

- Biological pollutants (molds, viruses, bacteria, pollen, house dust mites, cockroaches, and mildew).
  - Asbestos: (millboard, floor tiles, pipe, and furnace insulation materials, panels, ceiling tiles, coating materials, textured paints, and asbestos shingles).
  - Cooking or heating materials: (crop, wood, dunk cakes, bio-gas, electricity, charcoal, LPG, kerosene, coal, lignite, and coke).
  - Radon (cracks in concrete walls and floors, uranium in the sailor rock on which homes are built because uranium breaks down naturally and releases radon gas).
  - Building materials: (hardwood plywood paneling that is used for decorative wall covering in addition to its use in furniture and cabinets).
  - Particleboard used as shelving and subflooring in furniture and cabinetry, medium density fiber board for cabinets, drawer fronts and furniture tops).
- (Zhang Q., et, al, 2017)

### 2.2.2 The Major Health Damaging Indoor Air Pollutants:

POLLUTANT	MAJOR INDOOR SOURCES
VOLATILE AND SEMI-VOLATILE ORGANIC COMPOUNDS	FUEL/TOBACCO CONSUMPTION, FURNISHINGS, COOKING, CONSUMER PRODUCTS, AND CONSTRUCTION MATERIALS.
ARSENIC AND FLUORINE (COAL COMBUSTION)	COAL COMBUSTION

<b>CARBON MONOXIDE</b>	FUEL OR TOBACCO COMBUSTION
<b>SULFUR OXIDES</b>	COAL COMBUSTION
<b>FINE PARTICLES</b>	CLEANING ACTIVITIES, FUEL/TOBACCO COMBUSTION, OR COOKING.
<b>POLYCYCLIC AROMATIC HYDRO CARBONS</b>	COOKING, FUEL/TOBACCO COMBUSTION.
<b>ASBESTOS</b>	DEMOLITION OF CONSTRUCTION MATERIALS, REMODELING
<b>NITROGEN OXIDES</b>	FUEL COMBUATION
<b>BIOLOGICAL POLLUTANTS</b>	FURNISHINGS, MOIST AREAS AND VENTILATION SYSTEMS.

**TABLE(1): MAJOR DAMAGING INDOOR AIR POLLUTANTS**

### **2.3 Health Impact Of Indoor Air Pollutants:**

Approximately, half of the world's population is living in developing countries is harmfully exposed to IAP, which is responsible of causing 36% of all lower respiratory cases and 22% of chronic obstructive pulmonary disease (COPD), as well as IAP is considered as a major concern in the developed countries in where the energy efficiency developments can make homes relatively harmful through being airtight, increasing the pollutant levels and reducing the ventilation. Also there is a lack of

awareness that the indoor air environment can be dangerous through including different types of the same pollutants that are present outdoors. (Liu S., et, al, 2016)

In fact, indoor air pollution is not a new concern because the early human also exposed to the indoor air pollutants as smoke which result from the use of the fire at old times, and smoke pollution is one of its side effects because old people use fire indoor to warm their shelters, but nowadays there is an increasingly evident that the indoor environment is a major source of the self personal exposure to different air pollutants such as: volatile organic compounds (VOCs) and formaldehyde, and its important to note that some of these substances can reach fairly high concentrations. However, any health impact resulting from exposure to indoor air pollutants is a function of the total exposure, which is depending on different factors such as: the actual indoor compartment of exposure, exposure duration, population group exposed, frequency, and the air pollutant concentration. Indoor air pollutants include a wide range of pollutants that increase the risk of health concerns such as: ozone, sulfur dioxide, nitrogen, oxides, and particles. (Vornanen-Winqvist C., et, al, 2018)

In general, there are two different types of indoor air pollutants effect on health, the long-term (chronic) effects which occur after repeated or long periods of exposure to pollutants as long term effects of the inhalation of smoke which lead to obstructive pulmonary disease (COPD), adverse reproductive risks, lung cancer, chronic bronchitis, pregnancy-related problems such as: low birth weight and stillbirths.( Kim H.,et, al, 2018)

### **2.3.1 Health Concerns Due To Indoor Air Pollution (IAP):**

- i. IAP may lead to two different types of allergic disorders such as: extrinsic allergic caused by allergens in indoor air and allergic asthma.

- ii. Chemical compounds which are present in the indoor air may have mucosal or odorous irritation properties that could cause sensory effects.
- iii. Respiratory health problems such as chronic and acute changes in pulmonary function.
- iv. Increased mortality due to cardiovascular diseases (CVD).
- v. Lung cancer, which is the main common cancer caused by exposure to IAP.  
(Lucattini L.,et, al, 2018)

### 2.3.2 WHO Response To Indoor Air Pollution:

WHO provides technical support to countries in conducting their own assessments, and in scaling up fuels and health-promoting technologies for use in the home. WHO is seeking to increase various efforts at both international and regional levels in purpose to address indoor air pollution via direct consultations and workshops on energy at the level of healthy of household, in addition of the development of WHO clean energy toolkit and solutions which can be defined as a set of tools and information resources that helps countries to identify, implement, and monitor stakeholders involved in home energy in order to develop policies that control such concerns. (Huang Y., et, al, 2019)

### 2.3.3 Examples of the impact of indoor air pollutants on health:

Pollutant	Potential health effect
Nitrogen dioxide	Respiratory infection, exacerbation of asthma, wheezing, and lung infection in children

Particles	Chronic bronchitis, exacerbation of asthma, wheezing, cardiovascular disease, respiratory infection, COPD excess mortality.
Sulfur dioxide	Cardiovascular disease, exacerbation of COPD and asthma, and wheezing.
Carbon monoxide	Increased perinatal death, and low birth weight
Polycyclic aromatic hydrocarbing	Cancer of mouth, larynx and nasopharynx, in addition of lung cancer.

**Table (2): Examples Of Potential Risks Of Indoor Air Pollutants**

## 2.4 How Can We Reduce Indoor Air Pollution?

Everyday, pollutants can be present into the air of different homes through several ways, and this is can be very dangerous to human health which requires making an effort to prevent indoor air pollution and exposure to indoor air pollutants in addition of improving the indoor air quality through a series of solutions or effective steps such as the followings:

- ❖ Keep the home clean: clean home is a healthy environment, because good indoor hygiene prevents different pollutants from harming people's health, and cleaning efforts must focus on ways to minimize the accumulation of mold, dust, pet dander, and other pollutants that may be present in the home.
- ❖ Change filters: changing filters or forced-air heating systems regularly prevent the accumulation of dust and other airborne pollutants that may become trapped on it.

- ❖ Use an air purifier: these devices can help in capturing some of the pollutants or irritants that cause indoor air pollution which reduce the possibility of indoor air pollution.
- ❖ Let the fresh air enter the house: even in winter months, you should open windows regularly to allow fresh air to move into the indoor area and let the potential pollutants air out.
- ❖ Try to separate the kitchen area from other common rooms, to reduce the pollution of fumes or gases.
- ❖ Use stoves for heating and cooking.
- ❖ Developments in ventilation systems.
- ❖ Increase awareness programs towards indoor health concerns. (Peng Z., et, al, 2017)

## CHAPTER THREE: RESULTS AND RECOMMENDATIONS

### 3.1 Results:

**From the descriptive analytical approach of the study topic, we got the following results:**

- ✓ Indoor air pollution is a serious concern that can lead to difficult health effects, even death, as numerous studies over the years have shown that increased levels of different pollutants correspond to increased hospitalizations for asthma, cardiovascular diseases, lung cancer, infections, and chronic obstructive pulmonary diseases.
- ✓ Indoor air pollution can cause both, long and short term effects on health and it can cause serious conditions.
- ✓ Poor indoor air quality increase the risk of several dangerous diseases
- ✓ Indoor air pollution can be caused by different types of pollutants or compounds such as: VOCs, aldehyde, radon, formaldehyde, gases, biological agents, chemical agents, furniture, dust, and pesticides.
- ✓ Despite the fact that indoor air pollution is considered dangerous, we can reduce it through a set of strategies such as: using air purifiers and cleaning houses.

### **3.2 Recommendations:**

**Through this research, we recommend the following:**

- Increased the awareness that indoor air pollution can lead to serious health issues, and this can be done by different efforts including workshops, direct consultations, and lectures.
- Following the healthy steps that are put by WHO and specialists in order to reduce the exposure to indoor air pollutants.
- Focus on the importance of studying air pollution through conducting more scientific research and studies.
- Benefit from this study findings in the following studies that will discuss the same topic as a new add to the scientific library.

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## Conclusion

To conclude, indoor air pollutants are significant contributing factors that lead to several human diseases, and there are various types of these pollutants such as: CO<sub>2</sub>, CO, radon, aerosols, biological allergens, heavy metals, VOCs, PM, ozone and pesticides, all of which can cause a harmful effects on human health status. Most of the indoor air pollutants arise from two main origins, the first one is the transportation from the outdoor sources, however it is present at low concentrations indoor, and the second one is from the human activities that run indoor such as cleaning and combustion, operation of electronic machines, and use of certain building materials in the aim of renovation or construction. However, indoor air pollutants are risky to human health, it can be controlled and prevented by several strategies and approaches such as: the development of monitoring systems, sensors, and the smart home design.

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