## THE ATMOSPHERIC POLLUTION AND REPERCUSSIONS ON HUMAN HEALTH: A BRIEF REVIEW OF TOXICOLOGICAL ENVIRONMENTAL EFFECTS ON RESPIRATORY SYSTEM

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## ABSTRACT

Concern about the serious effects of pollution on human health was question paramount to the development of this study, such effects, demonstrated a significant relationship with the occurrence of respiratory tract diseases. This paper describes unsystematically, toxicological effects of air pollution caused in the body, based on other literary records. In general, disorders resulting from air pollution have been addressed since the time of the Industrial Revolution, when become new sources of pollutants due to burning fossil fuels in steel industries, as well as smoke from motor vehicles, which are launched in increasing quantities in the atmosphere. Thus, our goal is to describe the effects of air pollution on human health, specifically the respiratory system, thus give rise to new research involving these pollutants and show the relevance of having established criteria for monitoring air quality in order to be inspected, justified by the fact that breathing is an essential phenomenon for sustaining life.

**KEYWORDS:** Air pollution, respiratory diseases, air quality standards, toxicological effects, environmental exposure.

### **1. INTRODUCTION**

Despite progress made in recent decades in search of improved air quality, the damage inherent to human health are shown inevitable, after smoking, air pollution requires greater attention to be a relevant factor and trigger for respiratory diseases causing harmful effects to the individual short and long term, as well as other human diseases.

The interaction between man and the environment has become today, above all, an essential factor for their survival, however, there are aspects that disadvantage that sustainable thematic causing an imbalance in their own half, actions such as removing, build, consume and discard, are part of this cycle and become increasingly difficult to apply without major consequences for the ecosystem and especially for man.

Due to these facts in several countries including Brazil, air quality standards have been established and maximum

tolerated pollutants, from which the exposed population would suffer damage to health. In Brazil these standards have been established by the Brazilian Institute of Environment (IBAMA) and approved by the National Environmental Council (CONAMA) in 1990 through Resolution CONAMA 03/90<sup>1</sup>.

Although there are limitations for emission of pollutants into the atmosphere, it is estimated that in Brazil, about 13 thousand people die each year due to respiratory complications associated with particulate matter, beyond this fact air pollution also contributes to increased morbidity from respiratory diseases, cardiovascular, infectious, lung cancer and other exacerbations in the body, such as in chronic diabetes<sup>2</sup>.

Children and the elderly are the most affected by the action of pollutants in the body, since their immune systems are less developed and less efficient with respect to an adult, respectively. The effects caused by pollution on the human body depend on the agent, the intensity and location of aggression. These effects can appear either in the upper respiratory tract, as in the lower respiratory tract, with outcome in acute phase of transient events or the development of chronic diseases of the respiratory tract<sup>3</sup>.

The aim of this study is to describe the effects of air pollution on human health, specifically the respiratory system, thus give rise to new research involving these pollutants and show the relevance of having established criteria for monitoring air quality in order to be inspected, justified by the fact that breathing is an essential phenomenon for sustaining life.

## 2. MATERIAL AND METHODS

Since a pool of reflection between air pollution and respiratory diseases an investigation has been generated in order to produce knowledge on the subject. In this study, the choice was a literature review with descriptive approach. The bibliographic data used were obtained from the Google Scholar search site, SCIELO and government Lage et al. / Braz. J. Surg. Clin. Res.

to the Ministry of Environment, as well as newspapers and periodicals magazines. They were selected for the research articles in Portuguese that cover the period from 2001 to 2015.

In the survey the terms used were: air pollution, respiratory diseases, respiratory system physiology, bronchitis, asthma, pneumonia, lung cancer and air pollution, the articles were selected according to the proposed objective. A descriptive data that refer to the parameters of air quality of the city of Ipatinga - MG was used obtaining information from the database of the Municipality of Ipatinga -MG. The study was conducted between July and November 2015.

The air quality index is done by arithmetic average of 24 hours and has variables such as upper critical value and lower critical value of the index, maximum minimum concentration and the measured concentration of the pollutants. The analyzes were based on strategies: to list the literature explored evidence about the risks of developing respiratory diseases related to pollution.

## **3. LITERATURE REVIEW**

## Anatomy and physiology of the respiratory system

The respiratory system consists of: external nose, inner nose and paranasal sinuses, pharynx, larynx, trachea, bronchi and lungs. Structures such as pleura, diaphragm, chest wall and muscles that assist in the movement of the ribs also make up this system and are essential for breathing, each structure has its function and together realize the system goal is gas exchange<sup>4,5</sup>.

The respiratory system begins to develop in the prenatal phase of intrauterine life, its mechanism is complete only after birth in contact with the external environment at this stage is the maturation of pulmonary vessels capable of transporting carbon dioxide  $(CO_2)$  and oxygen  $(O_2)$ from the lungs and thus achieve an efficient gas exchange, however the respiratory system continues to develop until 7 years. After the development of the bronchial tree, pulmonary circulation is developed in parallel with the airway, a capillary bed is then formed around each well. Oxvgen and carbon dioxide need to diffuse across the alveolar epithelium. Epithelial cells from these wells, basement membrane of capillary endothelial, interstitial tissue and your present, liquid together form a tissue barrier that determines the ability of oxygen and carbon dioxide to conduct gas exchange<sup>6</sup>.

#### Diseases

In general, the analyzed studies report that children are more likely to develop complications of the respiratory tract, both acutely and chronically, because their immune system is not fully developed, secondly are the elderly who also suffer from the damage due to low efficiency of your immune system<sup>3</sup>. Among the main respiratory tract disorders are Bronchial Asthma, Pneumonia, Chronic Bronchitis or Chronic Obstructive Pulmonary Disease (COPD) and lung cancer, which are presented below in Table 1.

Table 1. Main diseases of the respiratory tract and its symptoms.

Diseases	Where and how it occurs	Symp- toms	Effects/ exposure
Bronchial asthma	Inflammation and airway obstruction.	They are episodic as dyspnea, wheezing, chronic cough, chest tightness usually in the evening or early morning hours.	Acute
Pneumonia	Inflammation of the lungs (alveoli) where gas exchange occur.	Cough with sputum, chest pain and rheu- matic fever which can reach 40 ° C, chills, ear pain and neck, wrist accelera- tion and wheezing.	Acute
Chronic bronchitis or chronic obstructive pulmonary disease (COPD)	Chronic inflammation of the bronchial tubes that can cause de- struction of lung parenchyma (emphy- sema).	Chronic cough with mucus, wheezing, cyanosis, fever may be associated with an infection.	Chronic
Lung cancer	Chronic inflammation due induced by car- cinogens, dispersed pollution.	Cough, dyspnea, wheezing, blood in sputum, chest pain.	Chronic

**Source:** Souza *et al.*  $(2010)^7$ .

These and other diseases affecting the respiratory tract have been the subject of research, especially the lower respiratory tract, because usually develop more slowly and are silent and can reach a chronic stage. As for the upper respiratory tract have been less studied in spite of treating acute diseases, on the other hand, the defense mechanisms of the organism, vary for each individual being that healthy persons can remove more easily inhaled particles that reach the upper airways while those with breathing problems are more vulnerable to inhalation of these particles end up coming to the bronchi and alveoli<sup>8</sup>.

#### Effects of pollution on the respiratory system

Large portion of world's population suffers from the effects of human actions, for they live in large urban centers where there is a continuous progression and increase of contaminants in the atmosphere, which suggest be responsible for increased morbidity and mortality rates related to respiratory tract diseases on a global scale the consequences are aggravated by the fact that the respiratory system has very close contact with the external environment.

High concentrations of air pollutants such as particulate matter, nitrogen oxide and ozone are suitable agents to an inflammatory response when these particles come into contact with the respiratory epithelium occurs a release of proteins such as chemokines and cytokines, by mediating cell to this answer and adhesion molecules, which is the result of oxidative stress caused by not destroying free radicals of oxygen and excess nitrogen in the airways. These free radicals are obtained exogenously from air pollution and damage cell structure and can take it apoptosis. The effects of the reaction depends on the agent, the intensity and location of aggression. These effects can appear either in the upper respiratory tract, such as runny nose, nasal congestion, cough, laryngospasm and vocal cord dysfunction, or in the lower respiratory tract, such as bronchitis, asthma, lung cancer, and other diseases<sup>3,9</sup>.

The increased blood flow and vascular permeability is the first phase of the inflammatory process of the airways, inducing neutrophils and other leukocytes to the site in question. Cytokines and chemokines function as biochemical mediators that make the signaling cells through the increase of the proteins and glycoproteins on the cell surface. The lung does not have toxic substances and for being the organ with more contact with the external environment has mechanisms that filter out microorganisms. These mechanisms involve the nose is the first barrier to the passage of larger particles. The matter which passes by the natural nose filter suffer muscle and ciliary trachea and bronchi by expectoration leading stuff out. The particles that are able to go through these two mechanisms and reach the alveoli, will suffer the action of alveolar macrophages responsible for lung protection by stimulating the body's immunity to the action of neutrophils<sup>10</sup>.

To Araújo  $(2011)^8$ , the Bronchial Asthma and other allergic diseases stand out with the highest prevalence in populations living in areas most polluted by particles from the burning of fossil fuels. In the same study conducted in the metropolitan region of the Steel Valley the quality parameters were discussed air based on the resolution of CONAMA (03/1990) and evaluation of chemicals based on World Health Organization standards (WHO), and correlated with the number of visits of respiratory tract diseases in the region.

According to the results presented it was noted that there is a correlation between the composition and concentration of these elements and steel activities and vehicle traffic in the area, which leads to stress the importance of studies of the relationship between climate and human health, focusing on is the multiplicity of aspects and surrounding environmental factors.

According Antoni *et al.*  $(2013)^{11}$ , above the recommended levels of pollutants in the atmosphere can lead patients to submit tachycardia and tachypnea as compensatory mechanisms for cellular hypoxia. Headache, nausea and vomiting are common symptoms. Syncope, pre-syncope and seizures are the result of cerebral vasodilation and cellular hypoxia also may cause cerebral edema. Angina, acute pulmonary edema and arrhythmias may result due to the increase in subsequent cardiac output.

Heart disease or lung disease may have exacerbated his symptoms. The classic findings of cherry-red lips, cyanosis and retinal hemorrhages occur rarely.

In a study in the city of Paulo, conducted by Gouveia (2006)<sup>12</sup>, involving children and the elderly can observe the association of increased concentration of pollutants with admissions for respiratory diseases are the most frequent asthma and pneumonia.

#### Pollutants found in the atmosphere

Carbon monoxide (CO) is the leading cause of death from poisoning and the most common worldwide. It is a colorless, odorless, flammable, and highly toxic. The exposure sources are formed of petroleum, gas, solid fuels and solvents which do not undergo complete combustion and can be found in large quantities in fire in automotive and release by industrial activity. When inhaled it goes into the bloodstream combining with hemoglobin and forming carboxyhemoglobin. This compound exhibits more affinity with hemoglobin for oxygen preventing the tissues and organs are oxygenated adequately. The negative effects caused by carbon monoxide poisoning depend directly on the concentration and duration of exposure to the substance<sup>13</sup>.

Nitrogen dioxide (NO<sub>2</sub>) is an air pollutant that has brown color and strong odor, being an oxidizing agent is very toxic. With motor car has its main source, the burning of fossil elements and industrial ovens in the form of nitrogen monoxide contribution is on a smaller scale. When released into the atmosphere it reacts with oxygen to form nitrogen dioxide. By having poor solubility reaches the most peripheral portions of the lung<sup>8</sup>.

Ozone (O<sub>3</sub>) is a colorless gas with a characteristic odor and that is formed by breaking of oxygen molecules by the effect of ultraviolet radiation. By having oxidant and germicidal action is commonly used in industrial activities and in water treatment. It is beneficial when produced naturally in the stratosphere by the photochemical action of ultraviolet rays having protective function against atmospheric pollution. But when harm has concentrated in the troposphere, the lowest layer of the atmosphere as a result of human action<sup>14</sup>.

They are defined as very fine particles of solid particles suspended in the atmosphere with diameters less than 100 microns, corresponding to the diameters less than 10 microns are characterized as inhalable particles. Derived primarily of dust, fog, smoke, aerosol etc. They are classified according to size, with most clinically relevant materials with diameters of 10 m and 2.5 micrometre (PM10 and PM2.5). Particulate matter is the most studied compound and the relevant association between environmental pollution and respiratory diseases<sup>15</sup>. According to the Ministry of the Environment (2015)<sup>16</sup>, studies indicate that the effects of particulate matter on health include cancer, arteriosclerosis, inflammation in the lungs, worsening

symptoms of asthma, increased hospital admissions and can lead to death.

The sulfur dioxide is one type of small particulate matter, toxic, colorless gas. Very soluble in water when inhaled SO<sub>2</sub> is absorbed into the most peripheral regions of the lung, and respiratory diseases triggering factor. Its main sources generating activities that are part of man's daily life as the use of cars and thermal as well as natural sources such as volcanoes. Are responsible for the worsening of symptoms of asthma, beginning as well as other pollutants to various respiratory problems<sup>17</sup>.

According to Gomes (2002) below is the pathogenic effects caused by PM pollutants, NO<sub>2</sub>, O<sub>3</sub>, SO<sub>2</sub> and CO, its target organ and its mode of action:

Pollutant	Target organ	Action mode and disease
		Exacerbates the response to other
PM	Respiratory system	toxic pollutants
NO <sub>2</sub>	Bronchi and alveoli	Irritation, inflammation, bronchi- tis, pulmonary edema and fibrosis
O <sub>3</sub>	Bronchioles and alveoli	Irritation, inflammation, difficulty fibrosis and respiratory
SO <sub>2</sub>	Bronchial tree	Activation of the bronchial re- ceptors causing difficulty breath- ing and bronchitis
СО	Blood and living cells of all organs	Carboxyhemoglobin formation in erythrocytes
Source: Go	omes $(2002)^{18}$ .	

Table 2. Pathogenic effects of inhaled particles.

Air Quality Monitoring

According to the Air Quality Index (AQI) the effect of toxic substances released is measured by capturing the concentration of pollutants in the atmosphere. This monitoring in the city of Ipatinga is done through booths located in four districts of the city (Bom Retiro, Cariru, Cidade Noble City and Veneza) who do the analysis and monitoring of these substances by means of sensors that determine the concentration of each pollutant, this It is in turn

connected to a color scale. Through the possible effects on the population can be established that air quality is classified into: good, fair, poor, bad and very bad<sup>19</sup>.

Due to increased motor vehicle fleet and intense industrial activity in the health region directly reflects the result of this contamination. Importantly, according to the World Health Organization health risks vary from place to place and can be interfered with by political and social factors in addition to the level of development and the ability to manage air quality<sup>20</sup>.

They are defined by Resolution No. 3/1990 of

CONAMA<sup>21</sup> standards for each type of pollutant and are classified as minimum and maximum limits. Total suspended particulates, respirable particulate matter, sulfur dioxide, carbon monoxide, ozone and nitrogen dioxide are the environmental parameters included in the monitoring network in the city of Ipatinga. These indicators were obtained by the Secretary of State for the Environment and Sustainable Development of Minas Gerais State, through the transparency portal.

The company responsible for the analysis of air quality in the city is Usiminas SA, which performs the measurement not only of pollutants emitted by it as well as the fleet of motor vehicles. The primary standards are equivalent to the maximum, ie, those who overcome will somehow cause harm to human health. As for the secondary standards are those corresponding to the minimum limits, ie those who are below cause the least possible effect the health of the population<sup>22</sup>.

#### Monitored parameters in the city of Ipatinga-MG

It is shown below the concentration of air pollutants included in the monitoring network in the city of Ipatinga between the years of 2013 and first half of 2015 at stations located in Bom Retiro neighborhoods, Cariru, Veneza and Cidade Nobre.

Resolution 03 of the National Environmental Council (CONAMA), of June 28, 1990, establishes the national norms and standards to control pollution caused by industrial activities, automobiles and other various types of vehicles. The conservation of environmental heritage is carried out by all federal entities.

Table 3. Pollutants monitored in the city of Ipatinga in the period 2013 -2015.

	В	om Reti	ro		Cariru			Veneza		Cid	ade Nol	bre
Parameter	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
Total Particles	35,9	37,9	32,2	31,8	36,3	40,6	38,5	-	31	33,3	34,4	34,6
Inhalable Particles	21,5	22,9	21	18,8	21,3	22,7	22	23,3	21,5	21,5	23,4	22,2
Sulfur dioxide	6,8	5,7	5,7	3,1	1,83	3,1	2,8	2,8	2,8	4,4	2,3	2,3
Nitrogen dioxide	11,1	10,5	11,8	10,9	10,7	10,9	14,8	12,4	12,4	12,9	10,5	9,5
Carbon monoxide	2,1	2,34	2,07	5,89	13,41	2,57	3,31	2,41	2,7	3,9	3,16	1,86
Ozone	139,3	198,1	172,6	155	184,4	184,4	131,4	162,8	129,5	178,5	174,6	155

Source: Prepared by authors

However, rests with the Ministry of Environment to perform environmental licensing of shares of industrial activity, air quality management and monitoring of it. Environmental monitoring is the responsibility of municipalities and the Department of Motor Vehicles (DMV), through its state duties is responsible for assessing the emissions caused by motor vehicles<sup>23</sup>.

On the concentrations defined as primary and secondary air quality standards, are presented in the following table:

#### Table 4. Air Quality Standards according to CONAMA.

Pollutant	Time to Sampling	Primary standard (μg/m <sup>3</sup> )	Secondary standard (µg/m³)
Total Particulate Suspension (PTS)	24 h MGA	240 80	150 60
Inhalable particles (MP10)	24 h MAA	150 50	150 50
Sulfur dioxide (SO <sub>2</sub> )	24 h MAA	365 80	100 40
Nitrogen dioxide (NO <sub>2</sub> )	1 h MAA	320 100 40.000	190 100 40.000
Carbon monoxide (CO)	1 h 8 hs	(35 ppm) 10.000 (9 ppm)	(35 ppm) 10.000 (9 ppm)
Uzone $(U_3)$	In	160	160

Source: CONAMA, 1990.20

#### 4. DISCUSSION

The study by Araujo (2011)<sup>10</sup> years shows data according to the WHO about two million people die each year as a result of problems caused by environmental pollution resulting from the burning of fossil fuels, forest burning and by industrial activity. The pollutants emitted by these activities can be fine particles, sulfur dioxide, carbon monoxide, ozone, and many other pollutants, and even being found in low concentrations in the atmosphere cause respiratory illnesses.

Analyzing the data obtained in relation to the monitoring of air quality in the city of Ipatinga and comparing the data with the standards established by CONAMA Resolution n° 03/ 90, we see high levels of some of the monitored pollutants. The values found for Total Particles, inhalable particles, sulfur dioxide and nitrogen dioxide can be classified as suitable, as none of them exceeded the values stipulated as acceptable by CONAMA Resolution n° 03/ 90. In relation to carbon monoxide, only Cariru season was larger than recommended, reaching the value of 13.41ppm.

Ozone however, was content analyzed with a higher occurrence of above values considered as acceptable, representing annual average in 2013 of 179.5 mg/ m<sup>3</sup> in Cidade Nobre station, with its high values in all seasons in 2014, with Bom Retiro with values of 198,1  $\mu$ g/ m<sup>3</sup>; Cariru 184,4  $\mu$ g/ m<sup>3</sup>, Veneza 162,8  $\mu$ g/ m<sup>3</sup> and Cidade Nobre 174,6  $\mu$ g/ m<sup>3</sup>, and with values of 172.6  $\mu$ g / m<sup>3</sup> at the station Bom Retiro and 184.4 mg / m<sup>3</sup> in Cariru station.

A study by Martins *et al.*  $(2002)^{24}$  which investigated the relationship between the number of patients with influenza and pneumonia and air pollution in Sao Paulo, Brazil, showed that sulfur dioxide was associated with the number of visits, but it was the only pollutant that did not show up values acceptable values. Which brings us to associate that even the pollutants emitted into the atmosphere rates have not exceeded the limit values, the population of Ipatinga who is in daily contact with this material, may have increased susceptibility to develop diseases affecting the respiratory system.

### **5. CONCLUSION**

Confirmed the deleterious effects of air pollution to respiratory just have to pay attention to the government about the enforcement measures in order to diminish the toxic damage caused by high concentration of pollutants. It is of paramount importance, the inclusion of professionals as pulmonologists and toxicologists in the adoption of environmental policies, since the organs of the respiratory system will be achieved by the air quality.

In all analyzed studies, the relationship with the increasing number of cases of respiratory diseases in people living in urban areas and are daily exposed to air pollutants that are released by industry and the burning of fossil fuels is each day more evident. Even though few studies specifically who demonstrate the effects that these pollutants cause in the body, we can see that every day more people are being affected by diseases of the respiratory system.

High levels of pollutants dumped into the atmosphere every day are enough to cause or aggravate any respiratory damage, however despite being below the acceptable concentration levels of air pollution can be harmful to health. This in fact draws attention to the need for other studies showing more precisely the relationship between the levels of pollutants and the effects that they can cause to human health.

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