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Correlation of Aggressive Environments and Operative Yielding of Manufacturing workers in an Electronics Industry of Mexicali

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Abstract- *This investigation was made to evaluate the correlation analysis of the presence of aggressive environments in indoor of an electronics industry installed in the Mexicali city, and its negative effect in low yielding of workers of the manufacturing areas, due to its weakened immune system and lung affections. This originated the generation of respiratory diseases as flu as the most common acute respiratory symptom in some workers, being the principal factor of a decrement of its productivity and quality levels. One of the relevant factors of this serious health symptom is the exposure to polluting particles from chemical agents (derived from sulfur (SO_2), nitrogen (NO^2) and carbon (CO)), which generated the aggressive environments. This was concerned to directive and manager personnel of the industry where was made the scientific study in was made this investigation, which was consisted four steps as (1) an analysis of operative yielding of workers of manufacturing areas, (2) an evaluation of environmental aspects as pollution agents and climatic parameters, which had relation with the sick workers of respiratory diseases as allergies and flue as the principal, (3) an improvement to clean the indoor environments of the electronics industry where was made the scientific study, using gases and finite particles of biological (fungi spores), chemical (SO_2, NO_2 and CO), and physical (finite dust), and (4) a microanalysis of microorganisms that were deposited in five plastic plates and evaluated with the Scanning Electron Microscopy (SEM), observing the presence of the microorganism called Aspergillus Fumigate, which caused the Aspergillus disease that originated an increase of the weakened immune system and the lung affections mentioned above in workers of the manufacturing, (.This scientific study was made from 2017 to 2019.*

***Keywords*:** Operative yielding, electronics industry, immune system and lung affections.

1. INTRODUCTION

One relevant aspect in any industries of the world, is the evaluation of the operative yielding of workers of the manufacturing aeras, which are very important

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in the growth of any type of industry of any region of the world. For this reason, the directive and managers, have evaluations of the persons that make the industrial operations steadily, to detect very fast when some workers do not have the efficient operative yielding, need know the causes and take decisions very fast (Li Z. et al, 2021). In this scientific study was made the evaluations at daily, weekly, monthly, seasonally and yearly; and was detected one a principal cause that was the presence of health symptoms in addition with inexpert workers of manufacturing areas (Anderson J. et al, 2012). This scientific study represents the relationship that generated the incidence of weakened immune system and lung affections in workers of manufacturing areas of the electronic industry where was made the investigation, which was caused by the exposition of various diverse types of agents shown in figure 1, represented by biological agents (fungi spores), chemicals (SO2, NO2, CO), physical agents (dust) and tiny particles such as $PM_{2.5}$ (less than 2.5 microns) and PM10 (less than 10 microns), which is a mixture of biological, physical and chemical agents of the aforementioned size (B.G. Lopez et al, 2010).

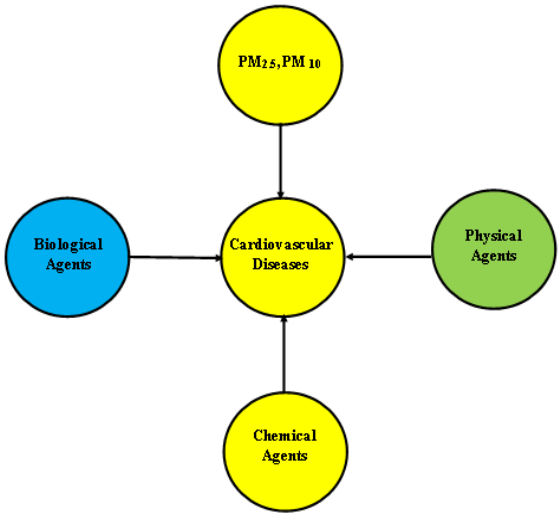

Fig -1:Pollution agents that generate cardiovascular diseases in Mexicali city (2021)

As is showed in figure 1, the agents described in this illustration and mentioned above, generated the weakened immune systems and lung affections, being caused by the four types of agents showed in this figure. These four agents were caused principally by the traffic vehicle and industrial companies that dump industrial waste on the ground, and that spread in outdoors atmospheres of these industries, remaining these agents suspended for various periods of time. These suspended particles enter to indoors of buildings through cracks, holes, crevices and roofs, originating in the electronic industry where was made the investigation, the incidence of health symptoms of the workers of the industrial operations (B. G. Lopez et al, 2007).

2. ELECTRONICS INDUSTRY IN MEXICALI

The electronics industry is very important in the world because a lot devices and equipments used in the real life by a lot people, are manufactured in this type of industry, and lot electronic systems are used in other type of industries as aerospace, agricultural, biomedical, food and beverage, metallic, plastics and textile industries. In this industry are fabricated diverse products being the best know cell phones, computers, microwaves, tablets and televisions; where is utilized the linear flow to manufactures great quantity of products, being able generates great quantity of errors if the linear flow is uncontrolled. Also, some specific electronic devices, systems and equipments can suffer of damage because have specialized sections that overpass the limit about electrical current or voltage (B.G. Lopez et al, 2010), can be, or are exposed to aggressive environments as the chemical agents mentioned above, can generates the corrosion phenomenon, and originate bad function. In the Mexicali city are 150 industrial companies from different countries, being from the United States the majorly and from Asian countries as Japan, China and Korea, essentially; and from

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Europe from England, France, Germany, Netherlands and Spain, principally (AMM, 2021).

3. ENVIRONMENTAL POLLUTION

In this scientific study, was made an analysis of five principal environmental agents observed in figure 2, which increased the grade of negative effect in the health of workers of the manufacturing areas (Elbarbary M. et al, 2021), which presented weakened immune system and lung affections, being a relevant aspect in the productivity and quality levels in this electronics industry evaluated. These environmental pollutants provided from the outdoor sources near of the electronics industry evaluated, as traffic vehicle, dump of waste from industries, biological waste from a hospital and three restaurants and waste dumped in soils and aquifers near of the industrial company where was made the investigation.

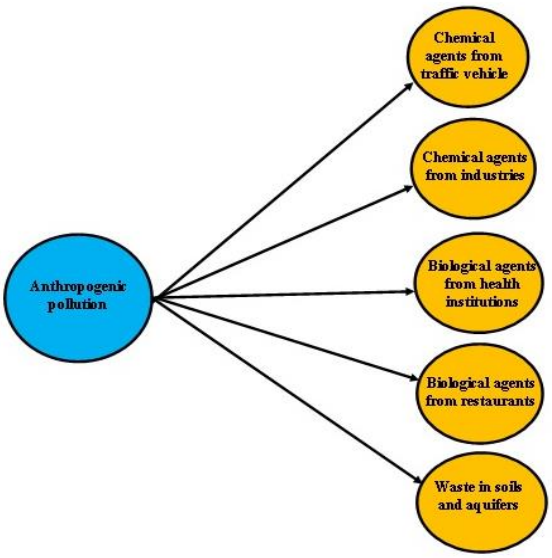

Fig -2:Anthropogenic agents of pollution in the Mexicali city (2021)

Figure 2 illustrates the five principal anthropogenic sources observed near of the industrial company where was made the investigation. The first agent was the traffic vehicle, because this electronics industry is located near a boulevard where transit a lot quantity of cars, principally from Monday to Friday, where a lot people need pass for this zone of the Mexicali city, because need to go your jobs. A lot motor vehicles in this border city are old (20 years old) and the majorly persons with low socioeconomical level, not make the maintenance of your cars, provoking the air pollution of the chemical agents mentioned above. The second agent was generated by the uncontrolled polluted gases from near industrial companies (metallic industries that use sulfuric acid and nitrogen acid to its industrial processes), of the electronics industry where was made the scientific study. The principal gases were the derivates of sulfur, nitrogen and carbon oxides (Goldberg M. et al, 2010). The third agent was considered as the biological pollutants from a big hospital, where in sometimes of the year dump biological waste, even when health and environmental authorities know this and allow it (Brunekreef et al, 2011). The four agent is same of the third, but the biological waste is from three restaurants near of the industrial company where was made the investigation, being the same aspect with the health and environment authorities of this city. The five agent was the waste dumped unconsciously of people that live near of the industrial company evaluated and contaminate the soil and aquifers near of this electronics industry where was made the scientific study.

4. CLIMATIC PARAMETERS

The principal climatic parameters as the temperature (°C) and relative humidity (%), were very important in this investigation, because for its variations (changing as low and high levels) were increased the negative effect in workers with weakened immune systems and lung affections of workers of manufactured areas of the electronics industry, where was made the investigation, and with this was presented a decrement in the operative yielding and for this reason appears errors, affecting the productivity and quality indices. The indoors of this industry was controlled the climatic parameters mentioned above, but in

periods as the summer season (with temperatures and relative humidity levels higher than 45 °C and 70%) and the winter season (with temperatures and relative humidity levels lower than 10 °C and 70%), in indoor of the industrial company evaluated, increased the grade of the persons with the health symptoms as weakened immune systems and lung affections (Lopez-Badilla Gustavo et al, 2012).

5.WEAKENED IMMUNE SYSTEMS AND LUNG AFFECTIONS

It is a worrying situation in people with respiratory health problems, mainly with obesity and cardiovascular problems, the elderly and children being the most affected. In the electronics industry where the research was made, the average age of the personnel in the manufacturing areas, who suffered from respiratory-type health symptoms, is 35 years old) (Wyatt L. et al, 2022), but people over 50 who have been hired for several years work. years. In this scientific study was presented around 40% workers with the health symptoms mentioned above, where are 1000 workers in the manufacturing areas in three shifts organized (6:00 AM to 2:00 PM, 2:00 PM to 10:00 PM and 10: PM to 6:00 AM from Monday to Friday).

6.SEM TECHNIQUE

Is a specialized technique used to evaluated at microscope scale any type of microorganisms and finite particles, principally, to determine its physicochemical characteristics and its effect can be generated in any type of action, as occurred in this investigation of the presence of the microorganism a fungi spore called Aspergillus Fumigate. This microorganism generated the Aspergillus disease and complicate the health of workers of the manufacturing areas with weakened immune system and lung affections and with this caused the origination of respiratory diseases and the decrease of the productivity and quality levels in the electronics industry evaluated (L. Veleva et l ,2008).

7. METHODOLOGY

This investigation was made to determine the grade of effect generated by the exposition of air pollutants and variations of climatic parameters in the generation of health symptoms of some organs of the human body and originated the cardiovascular diseases in the workers of an electronics industry located in the Mexicali city. This scientific study was made in four steps that are expressed now (ASTM, 2011):

a) Evaluation of operative yielding of workers. This step was made to determine the operative yielding workers of the manufacturing areas of the electronics industry evaluated, and the effect in the productivity and quality levels.

b) Analysis of air pollution and climatic factors and effect in the health of workers. In this step, was made an evaluation of the pollution and climatic factors to determine the principal pollution and climatic agent with major effect in the generation of the cardiovascular diseases in the electronics industry evaluated. In this step was used the air quality analyzer Aeroqual Series 500. Also, in this step was made an analysis of the principal aspects of the weakened immune systema and lung affections in workers of the manufacturing aeras of the electronic industry evaluated, which was generated by not take care of its health. This was made using a macroscopic method that consists in evaluate the color (green, yellow or transparent colors) and consistence (thick or liquid-like), being made by the health department of the industrial company evaluated.

c) Evaluation of an improvement to control the indoor air quality. This step was made to determine the grade of the improvement, when the industry evaluated was used specialized filters to detect and avoid entering from the outdoors environments to indoors of the company evaluated, to clean the

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indoor environment and decrease or avoid the generation of respiratory diseases as allergic and flu symptoms as the major type of respiratory diseases.

d) Microanalysis. This step was detecting some microorganisms with a plastic plate of 1 cm X 1cm, showing relevant results. In this step was used the FEI Tecnai F20, with was detected the Aspergillus Fumigate, which caused the Aspergillus disease that originated an increase of the weakened immune system and the lung affections.

8. RESULTS

This investigation represents a relation of the exposition to air pollution and the variations of climatic factors as expressed in the next sections, being the principal factors.

8.1 Analysis of environmental factors

The air pollution was evaluated to determine the grade of correlation between air pollutants and the climatic, observing that the SO_2 was the air pollutant that overpass the air quality standards in all periods of the analysis from 2020 and 2021. A relevant aspect evaluated was the decrease of the air quality levels from 2020 to 2021, because was made three principal actions: (1) reorganized the distribution plant (all industrial plants), (2) installation air filters to detect and not permit pass gases and particles to avoid the presence in indoor of polluted gases and particles as $PM_{2.5}$ and (3) use automatized systems to control temperature and relative humidity to not generate changes in this climate that originate health symptoms as respiratory symptoms and consequently cardiovascular diseases. This is represented in table 1.

Table -1: Analysis of environmental factors in indoor of the electronics industry evaluated (2018-2019)

Environmental Factors	Temperature, °C				Relative Humidty, %			
Seasons	SO_2	NO_2	CO	$PM_{2.5}$	SO_x	NO_2	CO	$PM_{2.5}$
2018								
Spring	0.79	112	13	43	0.81	115	15	47
Summer	0.66	105	10	39	0.70	110	11	43
Autumn	0.87	123	15	46	0.90	138	17	50
Winter	0.97	134	18	51	0.99	147	21	55
2019								
Spring	0.59	102	10	36	0.59	110	13	40
Summer	0.52	98	8	32	0.55	103	10	37
Autumn	0.68	107	11	39	0.72	111	14	43
Winter	0.76	118	13	42	0.79	122	16	46

Air Quality Standards. SO_2-0.5ppm at 1 hour, NO_2-100 ppb at 1-hour, CO-9ppm at 7 hours, $PM_{2.5}$-35µg/m^3 at 24 hours

Also, in this part of the investigation, was made an evaluation of the generation of the respiratory diseases as flu and allergies from 2017 to 2019. One aspect of importance was that in 2017 before the presence of the Covid9, was observed an increase of the repertory diseases and with the presence of the Covid19 pandemic, the quantity of these health symptoms increased very fast from 2020 to 2021, for the serious virus of this pandemic situation. Some people were sick in two of three times in this period of the time (in 2017), being a re-incidence and counted as new case.

Table -2: Correlation of pollution factors and cases of cardiovascular diseases (2017)

Pollution Factors Seasons (2019)	SO_2	NO_2	CO	$PM_{2.5}$
Spring	139	107	96	151
Summer	123	114	86	128
Autumn	168	129	108	169
Winter	181	141	129	183

8.2 Improvement using specialized filters

In this section of the investigation was used specialized filters to detect gases and finite particles of outdoor sources, and not enter to indoors atmosphere of the industrial company evaluated. With this improvement was made again the health analysis in 2018 as the last section and was

decreased the incidence of cases of health as is showed in table 3.

Table-3: Correlation of pollution factors and incidence of cardiovascular diseases (2018-2019)

Pollution Factors Seasons (2018)	SO_2	NO_2	CO	$PM_{2.5}$
Spring	96	79	61	127
Summer	90	70	58	114
Autumn	118	83	68	131
Winter	129	89	72	144
Pollution Factors Seasons (2019)	SO_2	NO2	CO	$PM_{2.5}$
Spring	88	71	53	105
Summer	82	62	47	95
Autumn	95	69	59	127
Winter	109	76	65	146

8.3 Microanalysis of polluting agents

To detect the presence of Aspergillus Fumigatus, it was necessary to carry out a test of respiratory secretion (sputum) in 20 workers who presented respiratory symptoms and a microanalysis was made with the scanning electron microscopy (MBE) technique, shown in figure 6, an appearance of the formation of Aspergillus Fumigatus at a scale of 100 µm (a) and 1µm (b), showing the presence of this biological contaminating agent illustrated in figure 3, which led several people from the manufacturing areas of the company to be evaluated.

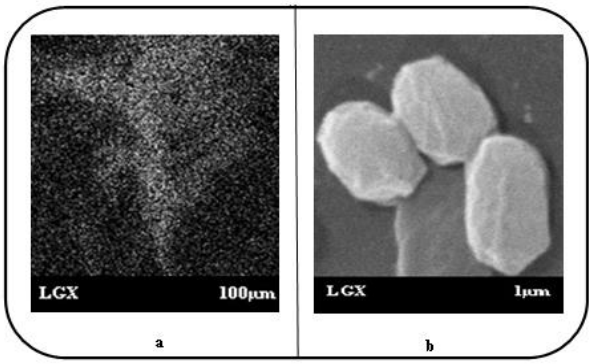

Fig -3:Aspergillus Fumigate with less of 2.5 micra of diameter as cologne (a) and individually (b) that caused respiratory diseases and consequently cardiovascular diseases in workers of manufacturing aeras of an electronics industry of Mexicali city evaluated (2021)

Figure 2 shows in section (a) as microphotography at 100µm, observing the formation of a cologne of Aspergillus Fumigate developed in a plastic small plate (1 cm X 1cm) of five plastic small plates installed in strategic places at 2 meters of height of an aera of the manufacturing processes of the industrial company evaluated. The section (b) represents at 1 µm, a microphotography of the presence of the agent Aspergillus Fumigate with more precision of its development. This caused the Aspergilosis disease, originating that the Aspergillus Fumigate penetrates to the conductive respiratory and are deposited in the lungs, causing a health symptom of cardiovascular diseases in the workers of the industrial plant evaluated.

9. CONCLSIONS

In this scientific study was observed the correlation level of the exposition to the pollution agents mentioned above, which in some periods of the investigation, showing the major effect specially in the winter season of each year evaluated, the generation of the respiratory diseases and consequently the origination of the respiratory disease in workers of the manufacturing aeras, caused by the weakened immune systems and lung affections of workers of manufactured areas of the electronics industry evaluated. The improvement actions of use of specialized filters of gases and very small particles avoid the penetration of these air pollutants from the outdoor provided from different sources, to indoor of the industrial company was made the scientific study. (Falta mas)

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