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Measurement of Air Pollutant levels and the Occurrence of Environmental Lung Diseases in Umuahia Metropolis, Southeastern Nigeria

Offiah, A.U.[1], Amadi, A.N.[2], Azuamah, Y.C.[3], Igwe, F.E.[1], Onyesom, E.[1]

[1]College of Medicine and Health Sciences, Abia State University, Nigeria
[2]Department of Public Health, Federal University of Technology, Owerri, Nigeria
[3]Department of Optometry, Federal University of Technology, Owerri, Nigeria

Corresponding Author: Offiah, A.U.

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ABSTRACT

Exposure to air pollutants can result to environmental lung diseases. This study was a cross-sectional study carried out at Umuahia metropolis, South-Eastern Nigeria to measure the level of outdoor air pollutants and assess the occurrence of environmental lung diseases among residents. An informed consent was obtained from all the participants in the study. Gas meters were used to measure the level of air pollutants at various outdoor locations and a well-structured questionnaire was used to obtain information from the residents. Results showed that the CO level in ppm was 182 at GPS location 5.52491N and 7.49460E; 181 at 5.52480N and 7.49226E; 183 at 5.52071N and 7.49603E; 186 at 5.52466N and 7.49711E; 190 at 5.52413N and 7.49488E; 185 at 5.52164N and 7.49491E. The SO_2 level in µg/m^3 was 470 at GPS location 5.52491N and 7.49460E; 512 at 5.52480N and 7.49226E; 492 at 5.52071N and 7.49603E; 480 at 5.52466N and 7.49711E; 504 at 5.52413N and 7.49488E; 552 at 5.52164N and 7.49491E. SPM levels in µg/m^3 was 1948 at GPS location 5.52491N and 7.49460E; 1915 at 5.52480N and 7.49226E; 1939 at 5.52071N and 7.49603E; 1955 at 5.52466N and 7.49711E; 1920 at 5.52413N and 7.49488E; 1963 at 5.52164N and 7.49491E. The mean CO value was 184.44±3.27; mean SO_2 was 501.62±29.02; mean SPM was 1940±19.20. The CO, SO_2 and SPM levels were significantly higher ($P<0.05$) than normal levels. The distribution of the respiratory complaints by the residents were coughing, 74(50.68%); sneezing, 83(56.85%); catarrh, 46(31.51%); asthma, 28(19.18%); short breath, 36(24.66%); pneumonia, 19(13.01%); wheezing, 67(45.89%); dizziness, 49(33.56%); breathing difficulty, 62(42.47%). Public enlightenment on the gaseous pollutants present at work places and possible health effects was recommended.

Keywords: Pollutants, Carbon Monoxide, Sulphur dioxide, Suspended Particulate Matter, Asthma, Pneumonia

INTRODUCTION

Environmental lung diseases are caused by harmful particles, mists, vapors, or gases that are inhaled, usually while people work. [1] If the lung disease is due to inhaled particles, the term pneumoconiosis is often used. Where within the airways or lungs an inhaled substance ends up and what type of lung disease develops depend on the size and kind of particles inhaled. Large particles may get trapped in the nose or large airways, but very small ones may reach the lungs. [2] There, some particles dissolve and may be absorbed into the bloodstream. Most solid particles that do not dissolve are removed by the body's defenses. The body has several means of getting rid of inhaled particles. In the airways, an accumulation of secretions (mucus) coats particles so that they can be coughed up more easily. [3] Additionally, cells lining the airways have tiny filaments

called cilia that stick out into the airways, and these filaments can brush inhaled particles upward, out of the lungs. In the small air sacs of the lungs (alveoli), special scavenger cells (macrophages) engulf most particles and render them harmless. [2] Many different kinds of particles can harm the lungs. Some are organic, meaning that they are made of materials that contain carbon and are part of living organisms (such as grain dusts, cotton dust, or animal dander). Some are inorganic, meaning that they usually come from non-living sources, such as metals or minerals (for example, asbestos). Common environmental lung diseases include asthma, emphysema, chronic obstructive pulmonary disease (COPD) and bronchitis.

Asthma is a condition in which the airways narrow and swell and produce extra mucus. This can make breathing difficult and trigger coughing, wheezing and shortness of breath. [4] Asthma symptoms vary from person to person. They include: shortness of breath, chest tightness or pain, trouble sleeping caused by shortness of breath, coughing or wheezing, a whistling or wheezing sound when exhaling, coughing or wheezing attacks that are worsened by a respiratory virus, such as a cold or the flu. [4] Exposure to various irritants and substances that trigger allergies (allergens) can trigger signs and symptoms of asthma. [5] Asthma triggers are different from person to person and can include: airborne substances, such as pollen, dust mites, mold spores, pet dander or particles of cockroach waste; respiratory infections, such as the common cold; physical activity (exercise-induced asthma); cold air; air pollutants and irritants, such as smoke, gases and particulates. [6]

Emphysema is a lung condition that causes shortness of breath. In people with emphysema, the air sacs in the lungs are damaged. Over time, the inner walls of the air sacs weaken and rupture, creating larger air spaces instead of many small ones. This reduces the surface area of the lungs and, in turn, the amount of oxygen that reaches the bloodstream. The main symptom of emphysema is shortness of breath, which usually begins gradually. [6] Factors that increase risk of developing emphysema include: smoking, age, exposure to second hand smoke, occupational exposure to fumes or dust, exposure to indoor and outdoor pollution.

Chronic obstructive pulmonary disease (COPD) is a chronic inflammatory lung disease that causes obstructed airflow from the lungs. Symptoms include breathing difficulty, cough, mucus production and wheezing. [7] It is caused by long-term exposure to irritating gases or particulate matter, most often from cigarette smoke. People with COPD are at increased risk of developing heart disease, lung cancer and a variety of other conditions. [3] Emphysema and chronic bronchitis are the two most common conditions that contribute to COPD.

Bronchitis is an inflammation of the lining of the bronchial tubes which carry air to and from the lungs. People who have bronchitis often cough up thickened mucus, which can be discolored. [8] Bronchitis may either be acute or chronic. Often developing from a cold or other respiratory infection, acute bronchitis is very common. Chronic bronchitis, a more serious condition, is a constant irritation or inflammation of the lining of the bronchial tubes, often due to smoking. [6]

Different types of particles produce different reactions in the body. Some particles such as animal dander can cause allergic reactions, such as hay fever–like symptoms or a type of asthma. Other particles cause harm not by triggering allergic reactions but by being toxic to the cells of the airways and air sacs in the lung. [9] Some particles, such as quartz dust and asbestos, may cause chronic irritation that can lead to scarring of lung tissue (pulmonary fibrosis). Certain toxic particles, such as asbestos, can cause lung cancer, especially in people who smoke, or cancer of the lining of the chest and lung (mesothelioma), regardless of the person's smoking history. The specific type of

environmental lung disease depends on the environment to which the person is exposed. [10] This study is aimed at measuring the level of outdoor air pollutants and the occurrence of environmental lung diseases among residents of Umuahia metropolis, Southeastern Nigeria.

MATERIALS AND METHODS

This study was a cross-sectional study carried out at Umuahia metropolis, South-Eastern Nigeria. The simple random sampling technique was used to select 146 residents of Umuahia to be part of the study. An informed consent was obtained from all the participants in the study. A well-structured questionnaire was administered to the participants to fill out and submit. At various outdoor locations in Umuahia, gas meters were used to measure the level of air pollutants. Tables were used to represent the data collected.

RESULTS

Table 1 showed that the CO level in ppm was 182 at GPS location 5.52491N and 7.49460E; 181 at 5.52480N and 7.49226E; 183 at 5.52071N and 7.49603E; 186 at 5.52466N and 7.49711E; 190 at 5.52413N and 7.49488E; 185 at 5.52164N and 7.49491E. The CO levels was significantly higher ($P<0.05$) than normal levels. Table 2 showed that the SO_2 level in $\mu g/m^3$ was 470 at GPS location 5.52491N and 7.49460E; 512 at 5.52480N and 7.49226E; 492 at 5.52071N and 7.49603E; 480 at 5.52466N and 7.49711E; 504 at 5.52413N and 7.49488E; 552 at 5.52164N and 7.49491E. The SO_2 levels was significantly higher ($P<0.05$) than normal levels. Table 3 showed that the SPM level in $\mu g/m^3$ was 1948 at GPS location 5.52491N and 7.49460E; 1915 at 5.52480N and 7.49226E; 1939 at 5.52071N and 7.49603E; 1955 at 5.52466N and 7.49711E; 1920 at 5.52413N and 7.49488E; 1963 at 5.52164N and 7.49491E. The SPM levels was significantly higher ($P<0.05$) than normal levels. Table 4 showed that the mean CO value was 184.44±3.27; mean SO_2 was 501.62±29.02; mean SPM was 1940±19.20. Table 5 showed that 74(50.68%) of the subjects complained of coughing; sneezing, 83(56.85%); catarrh, 46(31.51%); asthma, 28(19.18%); short breath, 36(24.66%); pneumonia, 19(13.01%); wheezing, 67(45.89%); dizziness, 49(33.56%); breathing difficulty, 62(42.47%).

Table 1: Carbon Monoxide levels at different outdoor locations

GPS Location North	GPS Location East	CO (ppm)
5.52491	7.49460	182
5.52480	7.49226	181
5.52071	7.49603	183
5.52466	7.49711	186
5.52413	7.49488	190
5.52164	7.49491	185
P-value = 0.00		

Table 2: Sulphur dioxide levels at different outdoor locations

GPS Location North	GPS Location East	SO_2 ($\mu g/m^3$)
5.52491	7.49460	470
5.52480	7.49226	512
5.52071	7.49603	492
5.52466	7.49711	480
5.52413	7.49488	504
5.52164	7.49491	552
P-value = 0.00		

Table 3: Suspended Particulate Matter (SPM) levels at different outdoor locations

GPS Location North	GPS Location East	SPM ($\mu g/m^3$)
5.52491	7.49460	1948
5.52480	7.49226	1915
5.52071	7.49603	1939
5.52466	7.49711	1955
5.52413	7.49488	1920
5.52164	7.49491	1963
P-value = 0.00		

Table 4: Mean values of pollutants at different outdoor locations

Pollutant	Mean	Standard Deviation
CO (ppm)	184.44	3.27
SO_2 ($\mu g/m^3$)	501.62	29.02
SPM ($\mu g/m^3$)	1940.00	19.20

CO: Carbon monoxide; SO_2: Sulfur dioxide; SPM: Suspended particulate matter

Table 5: Health complaints of subjects

Health Problem	n	%
Coughing	74	50.68
Sneezing	83	56.85
Catarrh	46	31.51
Asthma	28	19.18
Short breath	36	24.66
Pneumonia	19	13.01
Wheezing	67	45.89
Dizziness	49	33.56
Breathing difficulty	62	42.47

DISCUSSION

Measurements of gaseous levels were taken at different populated outdoor locations in Umuahia metropolis. Carbon monoxide levels were found to be significantly higher ($P<0.05$) than normal levels. The implication of this is that continuous inhalation and exposure of carbon monoxide gas by the inhabitants could result to adverse health effects. Hemoglobin in the blood has a higher affinity for carbon monoxide than oxygen and it combines with carbon monoxide to form carboxy-hemoglobin. Mild acute CO poisoning can cause light-headedness, confusion, headaches, vertigo, and flu-like effects. [11] Larger exposures can lead to significant toxicity of the central nervous system and heart, and death. Carbon monoxide can also have severe effects on the fetus of a pregnant woman. Chronic exposure to low levels of carbon monoxide can lead to depression, confusion, and memory loss. Carbon monoxide mainly causes adverse effects in humans by combining with hemoglobin to form carboxyhemoglobin (HbCO) in the blood. This prevents hemoglobin from carrying oxygen to the tissues, effectively reducing the oxygen-carrying capacity of the blood, leading to hypoxia. Inhaling CO gas can lead to hypoxic injury, nervous system damage, and even death. Different people and populations may have different carbon monoxide tolerance levels. On average, exposures at 100 ppm or greater is dangerous to human health. [12] Carbon monoxide exposure may lead to a significantly shorter life span due to heart damage. The carbon monoxide tolerance level for any person is altered by several factors, including activity level, rate of ventilation, a pre-existing cerebral or cardiovascular disease, cardiac output, anemia, sickle cell disease and other hematological disorders, barometric pressure, and metabolic rate. [13]

Sulfur dioxide (SO_2) was another gas that was measured at populated outdoor locations and was found to significantly higher ($P<0.05$) than normal levels. Because SO_2 is highly soluble in water, most inhaled SO_2 is absorbed by the mucous membranes of the upper airways with little reaching the lung; however, increased ventilation and oral breathing, such as from exercise, can raise the dose delivered to the lung. [6] SO_2 exposure has been associated with reduced lung function, bronchoconstriction (increased airway resistance), respiratory symptoms, and hospitalizations from cardiovascular and respiratory causes, eye irritation, adverse pregnancy outcomes, and mortality. However, it is difficult to attribute these reported associations to SO_2 itself, because it is a precursor to particulate matter and generally exists as a component of a complex, combustion-related pollutant mixture. Experimental studies[14,15] suggest that short-term exposures to high levels of sulfur dioxide can be life-threatening. Exposure to 100 parts of sulfur dioxide per million parts of air (ppm) is considered immediately dangerous to life and health. Long-term studies[16] surveying large numbers of children have indicated possible associations between sulfur dioxide pollution and respiratory symptoms or reduced breathing ability. Children who have breathed sulfur dioxide pollution may develop more breathing problems as they get older, may make more emergency room visits for treatment of wheezing and may get more respiratory illnesses than is typical for children. However, studies like these are unable to provide conclusive evidence about sulfur dioxide's effects on children's health because many other pollutants are also present in the air.

The levels of suspended particulate matter at the different outdoor locations were significantly higher than normal levels. When these particles are inhaled, the lungs produce mucous to trap the particles and tiny hairs wiggle to move the mucous and particles out of the lung. The mucous leaves the airway by coughing or swallowing. If the particle is small and it gets very far into the lungs, special cells in the lung trap the particles and then they can't get out and this

can result in lung disease, emphysema, lung cancer. Because the $PM_{2.5}$ travels deeper into the lungs and because the $PM_{2.5}$ is made up things that are more toxic (like heavy metals and cancer causing organic compounds), it can have worse health effects than the bigger PM_{10}. The effects of inhaling particulate matter include asthma, lung cancer, cardiovascular disease, respiratory diseases, premature delivery, birth defects, and premature death. Various studies[17,18] have indicated that $PM_{2.5}$ leads to high plaque deposits in arteries, causing vascular inflammation and atherosclerosis which can lead to heart attacks and other cardiovascular problems. The World Health Organization[19] estimated in 2005 that fine particulate air pollution ($PM_{2.5}$) causes about 3% of mortality from cardiopulmonary disease, about 5% of mortality from cancer of the trachea, bronchus and lung, and about 1% of mortality from acute respiratory infections in children under 5 years, worldwide. Short-term exposure at elevated concentrations can significantly contribute to heart disease. [20]

CONCLUSION

Results obtained from this study showed that the level of carbon monoxide, sulfur dioxide and suspended particulate matter were significantly higher than normal values at outdoor locations measured. Due to the presence of air pollutants, they had a history of respiratory problems including coughing, sneezing, asthma and pneumonia. It was recommended that the public be enlightened on the hazardous gaseous pollutants present in the environment especially at work places and their possible health effects.

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