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OCCUPATIONAL HEALTH RISKS (OHRs) AT FIVE SITES IN UYO METROPOLIS, SOUTH EASTERN NIGERIA

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Abstract: Noise, gaseous pollutants as well as meteorological parameters at five (5) locations involved with different occupational activities were estimated using Gasman portable digital air quality monitors and standard procedures, with a view to determining the health risks associated with these industrial/occupational activities. The selected locations for the study were geo-referenced using Garmin 60 GPS instrument. The data generated were compared with the instruments alarm/precision levels as well as the Nigerian Ambient Air Quality Standards and ACGIH standards. Mean noise levels of 78.3, 89.0, 70.4, 89.5 and 83.0 were obtained at Wastes Dumpsite, Champion breweries/Plastocrown, NNPC mega station, Itam flyover construction and Uniuyo mini market sampling sites, respectively. Apart from the Wastes Dumpsite and NNPC mega station, noise pollution pose serious health risks to receptors at the other sampling points when compared with statutory value of 80 dB(A). At the composite waste disposal site, a highest value obtained for Cl_2 was 0.5 ppm while the H_2S value was also highest (0.8 ppm) at this point. CO was equally highest (26.0 ppm) at this waste dump site as against the lowest value of 8.3 ppm at the Champion Breweries sampling site. All other gaseous pollutants estimated (SO_2, NO_2, H_2S, NH_3, Cl_2, HCN) had values well below the instruments alarm levels. SPM values of 51.0 ppm and 43.3 ppm were highest at roads/bridges construction and Wastes Dump sites, respectively. When compared with statutory limits, the high SPM and gaseous pollutants at some of the sampling stations pose some health risks. Detailed occupational health risks of the results generated from this study have been discussed and mitigation/amelioration measures proffered.

INTRODUCTION

Occupational health is concerned with the effects of workplace environment on an employee's health and also the effects of health on work and goes above and beyond the confines of health and safety compliance. The Nigerian Occupational Health and Safety Act No 85 of 1993 require that the workplace environment be safe and healthy for the employee and the employer

Pollution occurs as a result of man's activities in the environment, resulting in the emission of harmful substances that have deleterious or toxic effects on humans. The presence of pollutants in the atmosphere poses occupational health risk on the workers or residents that are in close proximity with the pollutants. Common atmospheric pollutants encountered in different occupational sites include: sulphur oxides (SOx), oxides of nitrogen (NOx), hydrogen sulphide (H_2S), Carbon monoxide (CO), sulphur dioxide (SO_2), hydrogen cyanide (HCN), Ammonia (NH_3), particulate matter, heat radiation and noise [(1)]. Some toxic air pollutants are present naturally in the environment in lesser amounts and may be beneficial or even essential to it. For example, sulphur dioxide, one major gaseous pollutant normally regarded as one of the most widespread pollutants occurs naturally in the atmosphere at low concentrations and helps to correct sulphur deficiency in some soils [(2)]. Sulphur dioxide only becomes a pollutant at much higher concentration caused by the burning of fossil fuel with high sulphur content.

Within Uyo metropolis, there are a number of industrial/occupational sites. Due to industrial processing, project construction activities, petroleum products marketing, industrial & municipal wastes disposal, etc. these sites may generate atmospheric pollutants that pose serious risks/threats to human health. Ekop[(3)] has documented environmental problems of Uyo metropolis. The noise levels,

air quality as well as meteorological parameters of these industrial/occupational sites in Uyo metropolis have not been determined. Moreover, the regulatory agencies have not been able to enforce the National Ambient Air Quality as well as the ACGIH standards for noise and air quality in Nigeria.

Risk is the likelihood and severity of hazard from exposure [4 and 5], thus:

Risk = Hazard x Exposure 1

Because of the enormous number of people usually affected, the impact of air pollution on cardiovascular disease represents a serious public health problem. Results from NIEHS-funded studies[6] have demonstrated a strong relationship between levels of airborne particles, sulfur dioxide, and other fossil fuel emissions and risk of early death from heart disease. The study showed that people living in the more polluted cities had a higher risk of hospitalization and early death from lung cancer and other respiratory diseases than those living in the less polluted cities[6].

This study was designed to determine the noise levels, noxious gases that are injurious to human health and some meteorological parameters of some selected industrial/occupational sites within Uyo metropolis where some activities like Industrial/manufacturing, petroleum products marketing, roads/bridges construction, waste dumping are carried out. This present study will provide regulatory agencies with the scientific data that will enable them to update the national ambient air quality standards.

MATERIALS AND METHODS

Description of Study Area

Five (5) occupational locations within Uyo metropolis (Champion Breweries/Plastocrown, NNPC Mega Station, Itam Flyover construction site, Uniuyo Mini Market, and Composite waste Disposal site) were randomly selected for sampling, based on the occupational activities going on, as shown in Table 1.

Table 1: Sampling locations and occupational activities at each site

S/N	Sampling Locations	Occupational Activities
1	NNPC Mega Station,	Petroleum Products marketing
2	Champion Breweries / Plastocrown	Industrial / manufacturing
3	Itam Flyover construction site,	Roads / Bridges construction
4	Composite waste Disposal site	Wastes Dump
5	Uniuyo Mini Market	Market

The map of the study area showing sampling points is as shown in Fig. 1 while photographs of the sampling locations are shown in Figures 2 - 6.

Noise Measurement

A sound indicator (Model Cs 15C manufactured by Castle Associates, Scarborough, England) was used for noise level measurement. Noise measurements were taken where other air quality parameters were taken. However, measurements were made at a height of 1.5m above ground level and in free-field conditions (i.e. away from acoustically reflective surfaces).

Air Quality Measurements

Air quality measurement were take at the six sampling location within Uyo metropolis using Gassman® portable Digital Gas Monitors (Table 2). Air Quality (gaseous emissions) parameters considered in this study included carbon monoxide, sulphur dioxide, nitrogen dioxide, hydrogen cyanide, hydrogen sulphide, chlorine and ammonia.

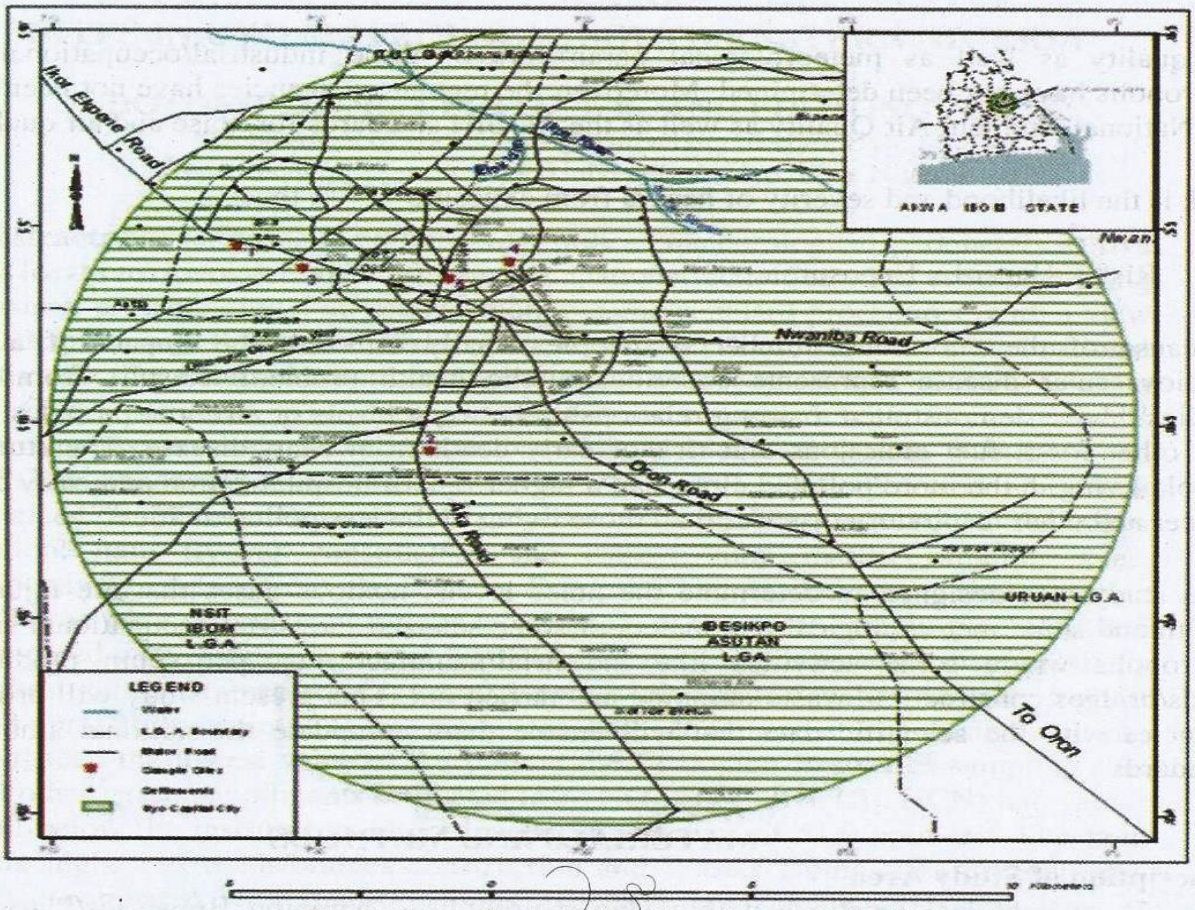

Fig. 1: Uyo Capital city showing sample sites

Fig. 2: NNPC Mega Station sampling location

Fig. 3: Champion Breweries/Plastocrown sampling location

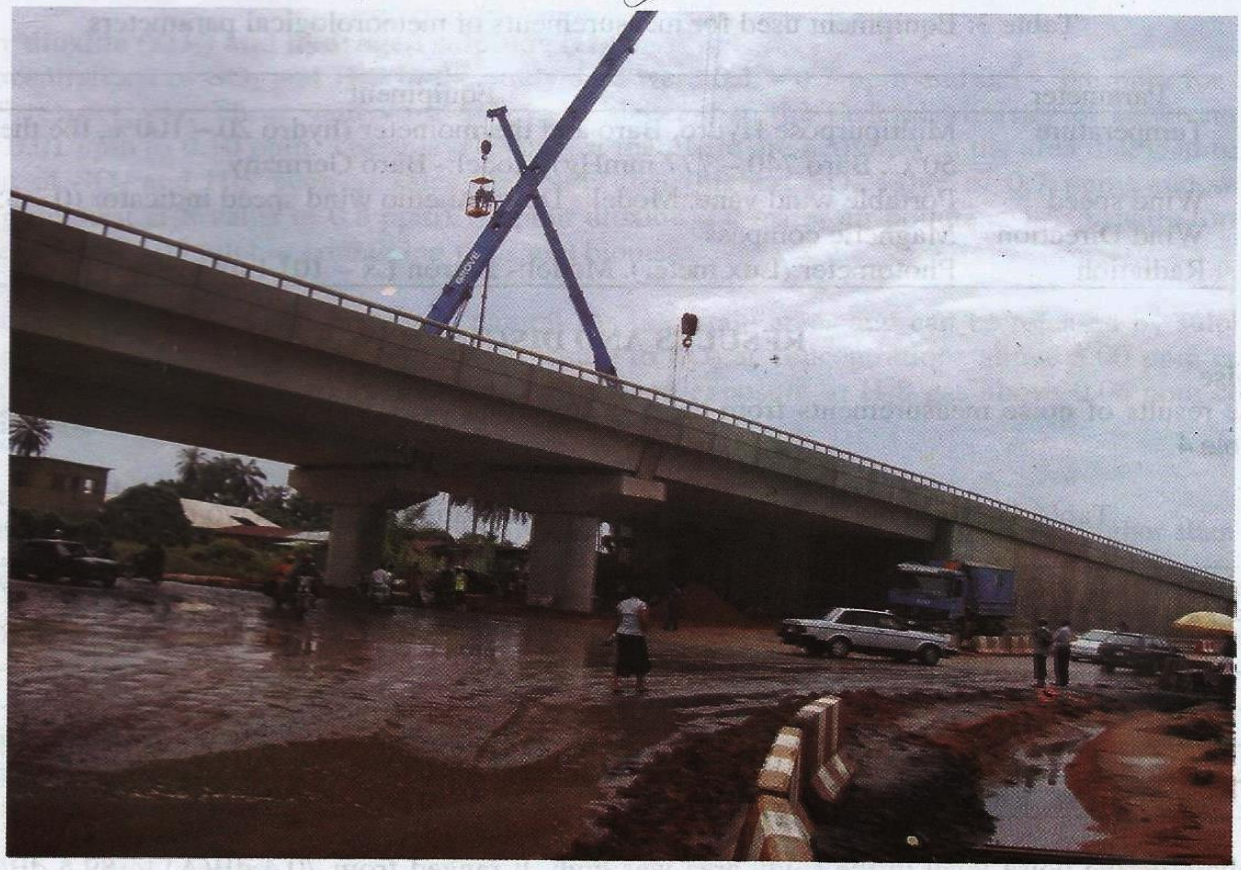

Fig. 4: Itam Flyover Construction site sampling location

At all the locations, the readings were taken by holding the equipment at arms length from the body. Features such as openness of the station, accessibility and wind direction were noted and utilized during the actual study.

Climate and Meteorology

The field data for the air quality analysis were those of Noise Pollution, Gaseous pollution, temperature, wind speed, wind direction and radiation. The measurement of the various meteorological parameters was carried out using in-situ portable pieces of equipment. These were as shown in Table 3

Table 2: In-situ Portable Air Quality Equipment Used

Parameter	Equipment	Range	Alarm Levels
Sulphur dioxide ($S0_2$)	50_2 gas monitor Gasman model 196484	0 – 10 ppm	2.0ppm
Nitrogen dioxide (NO_2)	NO_2 gas monitor Gasman model 19831 N	0 – 10ppm	3.0ppm
Hydrogen sulphide (H_2S)	H_2S gas monitor Gasman model 1972524	0 – 50ppm	10ppm
Ammonia (NH_3)	NH_3 gas monitor Gasman, model 19730H	0 – 50ppm	25ppm
Chlorine (Cl_2)	CL_2 gas monitor Gasman model 19812H	0 – 5ppm	0.5ppm
Hydrogen cyanide (HCN)	HCN gas monitor Gasman model 19773	0 – 25ppm	5ppm
Radiation	Radiation Alert ® monitor 4 SE international USA	0 – 5mR/h	0.5 mR/h
Suspended particulate matter (SPM)	HaZ – Dust TM 10N/Ms partic-waste monitor	0.1 – 200 ug / m^3	+ 1 – 0.02 ug/m^3

Table 3: Equipment used for measurements of meteorological parameters

Parameter	Equipment
Temperature	Multipurpose Hydro, Baro and thermometer (hydro 20 – 100%, the themo 10 – 50°C, Baro 740 – 777 mmHg) Model:- Baro Germany.
Wind speed	Portable wind vane. Model:- Derta Anemo wind speed indicator (0 – 35mls)
Wind Direction	Magnetic compass
Radiation	Photometer (Lux meter). Model:- Lutron Lx – 101 Lux meter.

RESULTS AND DISCUSSION

Noise

The results of noise measurements from the 5 occupational sites in Uyo metropolis are presented in Table 4.

Table 4: Noise measurements from the 5 occupational sites in Uyo metropolis

Noise Readings (dB (A)	Champion Breweries/Plasto Crown	NNPC Mega Station	Itam Flyover	UniUyo mini Market	Waste disposal site
1	91.7	75.9	89.4	80.1	76.4
2	87.2	69.2	90.5	82.3	81.3
3	88.1	66.1	88.7	86.5	77.2
Average values	89.0	70.4	89.5	83.0	78.3

Generally, the noise level in the study area was high. It ranged from 70.4 dB(A) to 89.5 dB(A). The highest level was recorded at Itam flyover construction site followed by 89.0dB(A) obtained at Champion Breweries/Plastocrown industry. Itam junction acts as a gateway into Uyo town and sound from moving vehicles also contributes to the noise at this location. The high levels obtained at the

flyover construction site could have been due to noise from all forms of construction vehicles used for the construction work. The lowest value was however obtained at NNPC mega station (70.4 dB(A)). When these values were compared with the ACGIH values (Table 8), noise pollution pose serious health risks to receptors at Itam flyover construction site and Champion Breweries/Plastocrown when compared with statutory value of 80 dB(A). Staff at this work site should be made to wear ear muffs for the 8-hour day while prolonged work hours should be avoided as much as possible.

Air Quality

The results of air quality measurements from the 5 occupational sites in Uyo metropolis are presented in Table 5. Detailed results for each of the components compared with the Nigerian Ambient Air Quality Standards (Table 9) are presented.

Carbon monoxide (CO)

Carbon monoxide concentrations measured in the study area ranged from 8.3 – 26.0 ppm. Four of the five locations studied had values higher than the maximum discharge range of 10.0 – 20.0 ppm for daily average of 8 hourly values in Nigeria. This is expected as Uyo, the project area is an urban city with its attendant combustion of fossil fuel.

The major sources of anthropogenic emissions are the technological processes of fossil fuel combustion and production, deforestation, land use changes and biomass burning. Sources of CO in the project area are massive vehicular emissions, diesel and petrol engines e.g. generating plants, welding machines and a lot of industrial, commercial and private activities that use fossil fuel. Prolonged and excessive exposure to ambient accumulation of CO values greater than 877 ppm could bring about formation of carboxy-haemoglobin and prevent oxygenation of blood leading to suffocation and consequent death.

Sulphur dioxide (SO_2) and hydrogen sulphide (H_2S)

The concentrations of SO_2 and H_2S in the study area were 0.1 – 0.7 ppm and 0.3 – 0.8 ppm for SO_2 and H_2S respectively. These values for SO_2 were higher than the Federal Ministry of Environment limit of 0.01 ppm to 0.10 ppm. These levels suggest that there are activities in the area that lead to the emission of SO_2 and H_2S such as sales of NNPC fuel (highest SO_2 value of 0.7 ppm) and waste dumping (highest H_2S value of 0.8 ppm). Sulphur dioxide is a major air pollutant. It is usually formed from the oxidation of sulphur containing fuels and biomass.

Hydrogen sulphide gas can be present in natural gas in certain areas and can be released by sulphate reducing bacteria in certain environments. Exposure to SO_2 at concentrations above 5.00 ppm could stimulate bronchio-constriction (as in asthma). Sustained exposure to H_2S gas above 0.06 ppm could result in death.

Nitrogen dioxide (NO_2)

The concentration of NO_2 at all the sampling sites was 0.1 ppm. This was however higher than the Federal Ministry of Environment limit of 0.04 – 0.06 ppm.

Nitrogen dioxide may be generated in the manifold of power generating plant. Long term exposure to NO_2 above 563 ppm may cause pulmonary diseases.

Ammonia (NH_3)

Ammonia levels highest value was 2.7 ppm in the study area. This was far below the Federal Ministry of Environment limit of 200 ppm.

Hydrogen cyanide (HCN)

The highest value of 1.7 ppm was obtained at the NNPC mega station. The concentrations at other locations were similar (0.1 ppm)

Fig. 5: Composite Wastes Dump Site sampling location

Fig. 6: University of Uyo Mini-market sampling location

Chlorine (Cl_2)

The highest value of 0.5 ppm was obtained at the composite waste disposal site. This value is alarming as it is the same with the alarming level of the equipment used for its determination. Other locations sampled had values of 0.2 and 0.3 ppm.

Table 5: Air Quality parameters from five sampling locations

Sampling Points	NO_2 Ppm	SO_2 ppm	H_2S ppm	CO ppm	NH_3 ppm	Cl_2 ppm	HCN ppm
Champion Breweries	0.1	0.1	0.6	8.0	2.0	0.4	1.0
	0.1	<0.1	0.4	9.0	1.0	0.2	1.0
	<0.1	<0.1	0.4	8.0	1.0	0.2	1.0
Average Values	0.1	0.1	0.5	8.3	1.3	0.3	0.1
Plasto Crown	0.1	0.1	0.7	21.0	3.0	0.1	2.0
	0.1	0.1	0.6	10.0	1.0	0.2	1.0
	0.1	0.1	0.5	11.0	3.0	0.2	1.0
Average Values	0.1	0.1	0.6	14.0	2.3	0.2	0.1
NNPC Mega Station	0.2	0.3	0.6	15.0	3.0	0.5	2.0
	<0.1	0.1	0.6	13.0	3.0	0.2	2.0
	<0.1	0.1	0.6	11.0	2.0	0.3	1.0
Average Values	0.1	0.7	0.6	13.0	2.7	0.3	1.7
Flyover	0.1	0.2	0.4	22.0	4.0	0.3	1.0
	0.1	0.2	0.4	21.0	2.0	0.2	1.0
	0.2	0.2	0.3	20.0	2.0	0.2	1.0
Average Values	0.1	0.2	0.4	21.0	2.7	0.2	0.1
Uniuyo mini Market	0.1	0.1	0.4	22.0	3.0	0.2	1.0
	0.1	0.1	0.3	21.0	1.0	0.2	1.0
	0.1	0.2	0.3	23.0	1.0	0.3	1.0
Average Values	0.1	0.1	0.3	22.0	0.7	0.2	0.1
Waste disposal site	0.1	0.3	0.8	23.0	3.0	0.4	1.0
	0.2	0.2	0.8	25.0	4.0	0.5	1.0
	0.1	0.2	0.7	30.0	4.0	0.5	1.0
Average Values	0.1	0.2	0.8	26.0	0.4	0.5	0.1
Alarm Levels(ppm)	3.0	2.0	50.0	50.0	25.0	0.5	5.0

Climate and Meteorology

The results of the meteorological parameters are shown in Table 6. Detailed results for each of the components are presented below.

Air temperature

During the fieldwork, the recorded temperatures were 25.0 31.5°c as shown in Table 6. This could be as a result of weather conditions during the fieldwork (peak of the dry season) and global phenomenon called climate change which is characterized by high temperatures in some instances.

Relative Humidity and Atmospheric Pressure

Atmospheric pressure was fairly constant throughout the sampling period ranging between 747.1 to 747.5 mmHg. The highest reading was at NNPC mega station (747.5mmHg) and the lowest at University of Uyo Mini market (747.1 mmHg).

The relative humidity is extent of air saturation by water vapour. Low relative humidity was recorded during the study which ranged between 20 40%. There is a positive correlation between

humidity and rainfall regime. The study was undertaken in the dry month of March (peak of dry season), hence the low humidity recorded.

Radiation

Very low levels of heat radiation were detected in the study area and did not pose any serious risk to workers or residents.

Table 6: Meteorological parameters, noise and vibrations.

Sampling points	Noise (dB(A)	SPM (ppm)	Heat Rad (mR/hr)	Rad (mR/ hr)	Temp (°C)	HUD (%)	Pressure (mmHg)	WD	WS (m/s)
Champion	80.4	14	171-175	0.34	25	32	747.2	N	0.5-1.5
Breweries	76.1	11	185-190	0.21	25	30	747.1	NE	0.5-1.0
	78.5	12	20-210	0.11	25	29	747.2	NE	0.5-1.0
Average values	78.3	12.3		0.22	25.0	30.3	747.2		
Plasto Crown	91.7	8	609-612	0.41	25.5	40	747.5	SW	1.0-2.0
	87.2	15	620-625	0.43	26	32	747.2	NE	1.0-2.5
	88.1	12	670-672	0.41	26.5	31	747.1	NE	0.5-1.0
Average values	89.0	11.7		0.47	27.5	34.3	747.5		
Mega Station	75.9	22	720-722	0.42	28.0	23	747.5	NW	1.5-2.5
	69.2	25	780-782	0.40	29.0	20	747.5	N	1.0-1.5
	66.1	27	790-792	0.34	29.5	20	747.5	NE	0.5-1.0
Average values	70.4	24.7		0.4	28.7	21.0	747.5		
Flyover	89.4	60	820-822	0.34	30.0	20	747.2	NE	0.5-1.0
	90.5	45	855-860	0.40	30.0	20	747.2	N	0.5-1.0
	88.7	48	901-902	0.40	30.0	20	747.2	NE	0.5-1.0
Average values	89.5	51.0		0.4	30.0	20	747.2		
Uniuyo mini	80.1	32	920-921	0.41	31.0	20	747.1	NW	0.5-1.0
Market	82.3	36	928-930	0.41	31.0	20	747.1	NW	0.5-1.0
	86.5	38	941-942	0.41	31.5	20	747.1	SW	0.5-1.0
Average values	83.0	35.3		0.4	31.2	20	747.1		
Waste disposal	76.4	40	1112-1115	0.50	31.5	33	747.5	SW	0.5-1.0
site	81.3	42	1210-1222	0.51	32.0	33	747.0	SW	0.5-1.0
	77.2	48	1234-1300	0.52	32.0	31	747.8	W	0.5-1.0
Average values	78.3	43.3		0.5	31.9	32.3	747.4		

Suspended particulate matter (SPM)

The value obtained for SPM ranged from 11.6 ppm Champion Breweries / Plastocrown Company to 51.0 ppm (Itam flyover construction site). This is comprised of fine solid and liquid particles 0.01 to over 100 microns in diameter suspended in ambient air. Potential anthropogenic sources of SPM in the study area include fumes from welding activities, exhaust fumes from vehicles, power generators and flyover construction activities (from cement, dust and construction vehicles). High concentrations of SPM are known to irritate the mucous membranes thus aggravating respiratory and cardiovascular diseases[9].

CONCLUSION

It is important to note that the human health effects of air pollutants are far reaching, but principally affect the body's respiratory system and the cardiovascular system. Atkins Research & Development Centre[7] summarized the health effects of some atmospheric pollutants (Table 7). According to EPA[8], individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, the individual's health status and genetics. The health effects caused by air pollutants may range from subtle biochemical and physiological changes to difficulty in breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and even premature death.

Air pollution can affect both the respiratory and cardiac systems. According to Smith[9] and Fischmann[10] the health effects of air pollution can be seen as a pyramid (Fig. 7), with the mildest but not common effects at the bottom of the pyramid, and the least common but more severe at the top of the pyramid. The pyramid demonstrates that as severity decreases the number of people affected increases.

Table 7: Health Effects of Some Atmospheric Pollutants.

Agents/Pollutant	Effects
Sulphur dioxide (So_4, etc.)	Aggravation of respiratory disease; impairment of pulmonary functions; irritation of eyes and pulmonary tract; leaf injury and reduced growth in plants, corrosion of metals.
Sulphur oxides and particulate matter from combustion sources	Short-term increase in mortality and morbidity; contributory role in etiology of lung cancer (?)
Particulate matter otherwise specified	Increase in chronic respiratory disease; impairment of visibility.
Hydrocarbons	Contribution of cancer (?); sensory irritation
Carbon monoxide	Reduced tolerance for exercise, impairment of mental functions
Nitrogen dioxide	Aggravation of cardiovascular and respiratory illnesses.
Lead	Increased storage in body; impairment of learning and intelligence in children
Hydrogen sulphide	Increase mortality from acute exposures, impairment of sensory detection/reflexes.

Source [7]

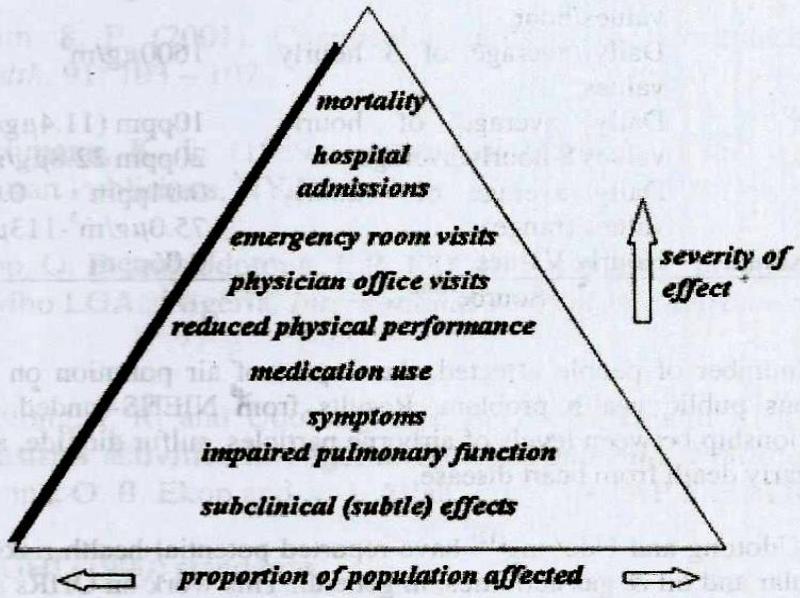

Fig. 7: Health effects of air pollution pyramid

Air pollution exacerbates the condition of people with respiratory and cardiovascular diseases and causes measurable increases in the rates of hospitalization for these diseases. Respiratory and cardiovascular diseases are among the leading causes of hospitalization in Canada[6]. In 1996-1997 there were 3.16 million hospital admissions in Canada of which cardiovascular and respiratory diseases accounted for 15% and 9%, respectively.

Long-term exposure to air pollutants increases the risk of respiratory illnesses such as allergies, asthma, chronic obstructive pulmonary disease, and lung cancer. Children and the elderly are particularly vulnerable to the health effects of ozone, fine particles, and other airborne toxicants. This research has resulted in the development of more stringent air quality standards that promote a higher quality of life, protect the health of children, the elderly and other vulnerable populations, and reduce the costs associated with respiratory disease.

Table 8: Permissible noise exposure – ACGIH standards

Duration/Day-Hour	Sound level (db(A)
8	90
6	92
4	95
3	97
2	100
1	102
11/2	105
1/2	110
1/4	115

Source [13]

Table 9: Nigerian ambient air quality standard

Pollutant	Time of Average	Limits
Particulates	Daily average of daily values/hour	250$\mu g/m^3$
Sulphur oxides	Daily average of daily values/hour	600$\mu g/m^3$
Non methane hydrocarbon	Daily average of 3 hourly values	1600$\mu g/m^3$
Carbon monoxide	Daily average of hourly values 8 hourly average	10ppm (11.4$\mu g/m^{3)}$ 20ppm 22.8$\mu g/m^{3)}$
Nitrogen oxides	Daily average of hourly values (range)	0.04ppm - 0.06 ppm 75.0$\mu g/m^3$-113$\mu g/m^3$
Photochemical Oxidant	Hourly Values	0.06ppm

Source [14]

Because of the enormous number of people affected, the impact of air pollution on cardiovascular disease represents a serious public health problem. Results from NIEHS-funded studies[6] have demonstrated a strong relationship between levels of airborne particles, sulfur dioxide, and other fossil fuel emissions and risk of early death from heart disease.

Ekop and Udotong[11] and Udotong and Udotong[12] have reported potential health risks in Mbo LGA due to gas flaring in particular and oil & gas activities, in general. This work on OHRs at occupational sites in Uyo metropolis, the State capital of Akwa Ibom State, the highest oil producing State in Nigeria was a follow up of their previous studies. The authors hereby concluded that future researches on air quality studies and occupational health hazards in Uyo metropolis must be built on these studies to identify those individuals and populations who are most susceptible to the effects of these air pollutants.

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