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Indoor and Outdoor Air Quality In Hospital Environment

[1*] Ediagbonya,T.F. [2]Tobin,A.E, [3].Legemah,M,

1.Department of Chemical Science,Ondo State Science and and Technology,Okitipupa.
2. Institute of Lassa Fever Research and Control, Irrua Specialist Teaching Hospital, Irrua 3.Department of Chemistry,University of Houston
Email:tf.ediagbonya@gmail.com

ABSTRACT:

The objective of this study is to determine the indoor and outdoor concentration ratio of suspended particulate matter. Spatial variation was performed by use of portable, SKC Air Check, high volume Gravimetric sampler with flow rate of 2L/min and a sampling duration of fight hours maintained during this pilot study, which was conducted between December 2010 to February 2011 in five different locations. The indoor particulate matter (I.P.M) found in the range of 243.05-451.39 while the Outdoor Particulate Matter (O.P.M) was in the range of 451.39-625.00. The correlation between the outdoor and indoor particulate matter was positive. (r = 0.491). The spatial variation of both indoor and outdoor particulate matter was significant and remarkable.

Keyword: Indoor air quality; outdoor air quality; particulate matter, spatial variation.

1.0 INTRODUCTION

Outdoor air enters and leaves house by infiltration, natural and mechanical ventilation. In a process known as infiltration, outdoor air flows into the house through openings, joints cracks in wall, floors and ceilings and around windows and doors. The rate at which outdoor air replaces indoor air is described as air exchange rate (Columbian encyclopedia, 2006).

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in homes. Offices inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoors sources and by not carrying indoor air pollutants out of the home or office. High temperature and humidity levels can also increase concentration of some pollutants (Patterson *et al.,* 2000; Gauvin e*t al*., 2002.)

Indoor Air Quality (IAQ) has gained great attention in recent years; chiefly due to large amount of time we spend indoors in modern times. (Jerkin *et al*., 1992) showed that urban people spend an average 87% of their indoors and only a mere 6% outdoors.

The industrialization/urbanization process has both positive and negative effects on indoor air quality in many cities of the world (Kim, 1992). Outdoor pollutant concentration may not be reliable indicators of indoor and personal pollutant sources (Wallace et al 1997).

The early studies on relationship between indoor and outdoor pollutants conducted in the 1950s and summarized by (Anderson, 1972), showed that there was great variation between indoor and outdoor ratio.(Benson *et al*., 1972) concluded in their review that in general,the ratios of indoor and outdoor pollutants concentration were about one. Since then a number of studies on the relationship between indoor and outdoor pollutant have been conducted (Dasrout *et al*., 1998; Spengler *et al*., 1981, Quacken boss *et al*., 1989; Janssen *et al.,* 1998; Monn *et al*., 1995; Ross *et al.,* 1999). (Baek *et al.,* 1997) examined indoor/outdoor concentration relationships for a number of pollutants (namely particulate matter, $C0_2$, $N0_2$ and a range of VOCs) in homes, offices and restaurants in Korean urban areas. (Mc Cann *et al.,* 1999) examined traffic pollution in and around City-Center, commercial properties in the U.K. (Kingham *et al.,* 2000) studied the spatial variation of traffic-related pollutant's concentration existing between indoor and outdoor air pollutant levels.

In summary, despite the huge variety of these studies in terms of conditions and results, most of them were able to demonstrate a certain degree of correlation between indoor and outdoor air with such relation depending obviously on large number of factors like generation efficiency from outdoor to the indoor environment and the particle deposition rate on indoor surfaces (Shair and Heitner ,1974; Kamens *et al.,* 1991; Athatcher and Layton, 1995) indoor surfaces (Shair and Heitner, 1974; Kamens *et al*., 1991; Athatcher and Layton ,1995).

It has been estimated that about half a million women and children die each year from indoor air pollution in India (Smith, 2000) and they also suffer increased prevalence of respiratory symptoms and disease (Qin *et al*., 1991, Peng *et al*., 1998; Schwela, 1997) from wide range of air pollutants are generated outdoors and are either known or suspected of causing adverse effects to human health and environment (DETR, 2000).

The toxicological studies have equally implicated particle air pollution in adverse health effects (Linn *et al.,* 1994; Mauderly, 1994; Anderson *et al*., 1999).

2.0 Materials and Method

2.1 BACKGROUND TO THE STUDY AREA

The study was carried out at the University of Benin Teaching Hospital (UBTH) Benin City, Nigeria.

The teaching hospital comprises several departments which include: Surgery, Orthopedics and Trauma, internal medicine, child health, obstetrics and gynecology, mental health and community health, radiology, pathology, family medicine and dentistry. There are also general practice clinic (GPC) and store and supply and the Account Department, Accident and Emergency (A & E) units which are an out patient's arrangement. Burning of waste product, the use firewood by food vendors, photocopier and vehicular movement, the use of rug in office, and printers are veritable sources of particle.

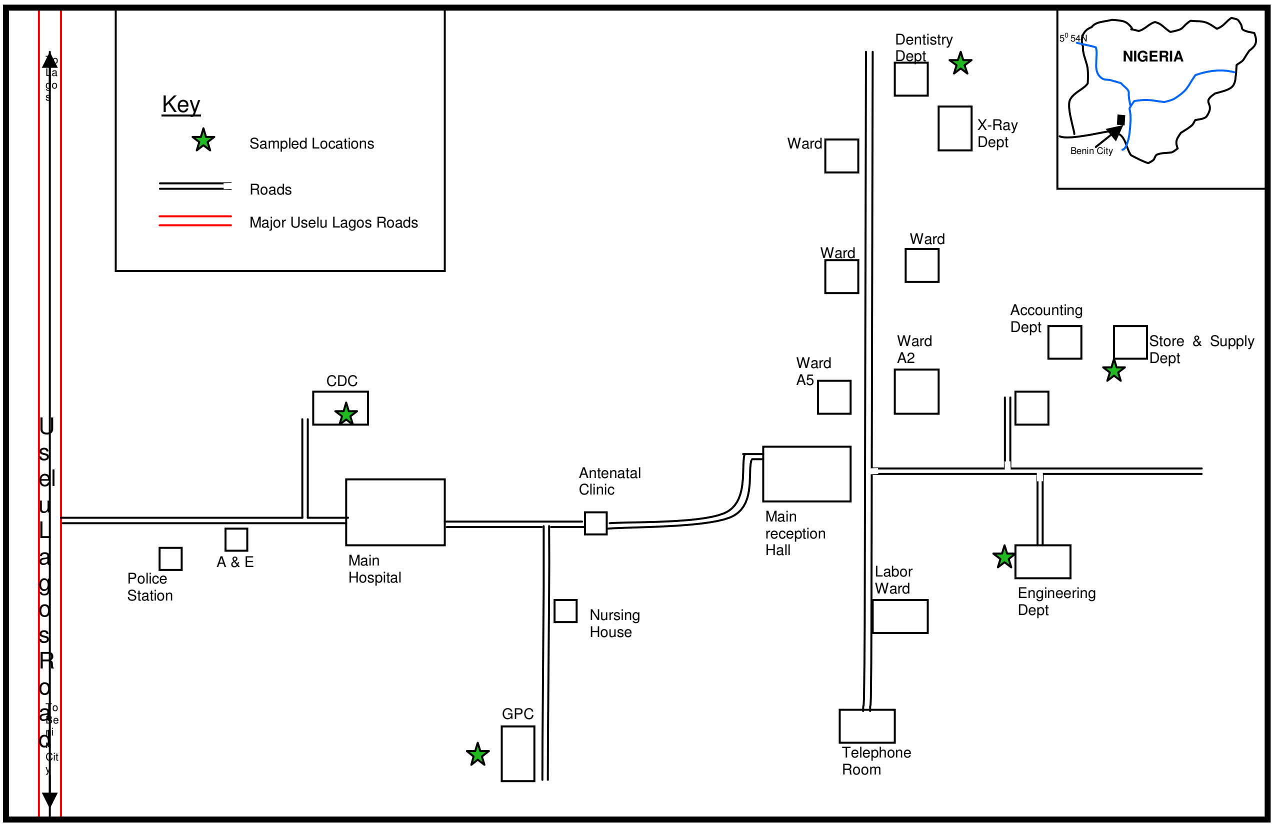

Figure 1: Map of UBTH showing the sampled locations

2.2 Sampler and Analytical Procedure

SKC Air Check XR 5000 high Volume Gravimetric Sampler Model 210- 5000 serial No. 20537.

The in-built gas flow meter has a rating of 1000 to 5000ml/mm of air samples, which was calibrated into 2000ml/min. Before sampling, all unloaded glass fiber filters were dried in desiccators at room temperature and their initial weights were taken. The particulates were collected on the pre-weighed filter by pumping

2000ml/min (2L/min) volume of air through it for eight hours, after sampling, the loaded filters were again desiccated and re-weighed to determine the final weight.
The concentration of the total suspended particulates in the air was determined from the difference in weight of the filter paper after and before sampling the duration of the sampling and the flow rate. (Shaw, 1989; UNEP/WHO, 1994).The sampler was placed at heights of 1.5m above ground level to reflect the breathing zone of human.

3.0 RESULTS AND DISCUSSION

As with homes, the most important factor influencing indoor air quality is the presence of pollutant source. Commonly found office pollutants and their sources include environmental tobacco smoke, asbestos from insulating and fire-retarded building supplies, formaldehyde from pressed wood products, other organics from building materials, carpet and other office furnishings, cleaning materials and activities, restroom, air fresheners, print shops. Biological contaminants from dirty ventilation systems or water-damaged walls ceiling and carpets and pesticides from pest management practices are other sources of contaminants.

The spatial variation was significant (P<.0.5) and the data generated exceeded the WHO (150-230µg/m^3) and FEMENV. This agency charged with the task of protecting, restoring and preserving the Ecosystem is the Federal Ministry of Environment (FMENV). This body hitherto called Federal Environmental Protection Agency (FEPA) was established by decree No. 58 of 1998. This agency has established air quality standards called Nigeria Ambient Air Quality Standard. The regulatory limit of suspended particulate is 250 µg/m(daily average). The reason for the non-attainment can be attributable to re-suspended dust, burning of waste products, the use firewood by food vendors, photocopier and vehicular movement, the use of rug and carpet in offices, air fresheners and printer.

Table 1:The Mean Concentration of outdoor suspended particulate matter.

S/N	SITES	MEAN	STD. DEVIATION
1.	General out Patient Clinic	451.39	159.12
2.	Account Department	625.00	104.17
3.	Dentistry Department	520.83	104.17
4.	Community Health Department	516.67	202.12
5.	Store and Supply Department	486.11	216.84

Table 2: The mean Concentration of indoor suspended particulate matter

S/N	SITES	MEAN	STD. DEVIATION
1.	General out Patient Clinic	277.78	60.14
2.	Account Department	451.39	60.14
3.	Dentistry Department	347.22	60.14
4.	Community Health Department	243.05	60.14
5.	Store and Supply Department	312.50	104.17

Table 2: Shows the Indoor Mean Concentration from the data generated, the WHO and the Nigeria Standard were clearly exceeded except in site 4 which falls within the purview of the Nigeria Standard. The ratio of outdoor to indoor was between 1 and 3. The spatial variation of the indoor concentration was also significant.

The percentage (100%) of the total variance in the analyzed data that was explained by the extracted principal component varies from 74.54%- 25.46%. The major sources of pollution are re-suspended dust, vehicular emission, burning of firewood and incineration solid waste.

Toxicity potential (TP): because of the exposure to particulate matter every day the tendency of human health effect exist thus the toxicity potentials are calculated viz:

$$T\,P = \frac{\text{measured outdoor paticualte matter concentration}}{\text{Regulatory limit } (250\mu g/m^3)}$$

By definition, the toxicity potential exceeding unity gives cause for concern.
Table 4and 5 show the toxicity potential for both indoor and outdoor particulate matter. From Table 4, the toxicity potentials were more than unity and fell between the range of 1.81 and 3 while in the outdoor the toxicity potential fell between the range of 0.97 and 2 in all the sites.

Table 3: The Ratio of outdoor to indoor concentration

S/N	SITES	RATIO
1.	General out Patient Clinic outdoor/indoor	1.62
2.	Account Department outdoor/indoor	1.38
3.	Dentistry Department outdoor/indoor	1.5
4.	Community Health Department outdoor/indoor	2.43
5.	Store and Supply Department outdoor/indoor	1.56

Table 4: The toxicity potentials of outdoor particulate matter

S/N	SITES	TOXICITY POTENTIAL
1.	General out Patient Clinic	1.81
2.	Account Department	2.50
3.	Dentistry Department	2.08
4.	Community Health Department	2.07
5.	Store and Supply Department	1.94

Table 5: The toxicity potential of indoor particulate matter

S/N	SITES	TOXICITY POTENTIAL
1.	General out Patient Clinic	1.11
2.	Account Department	1.81
3.	Dentistry Department	1.39
4.	Community Health Department	0.97
5.	Store and Supply Department	1.25

3.1 Correlation of outdoor and indoor level of particulate matter

Fig.2 Shows the correlation between the outdoor level and indoor level of TSP within UBTH. The was an insignificant correlation between the mean ($r = 0.829$, $p = 0.083$)

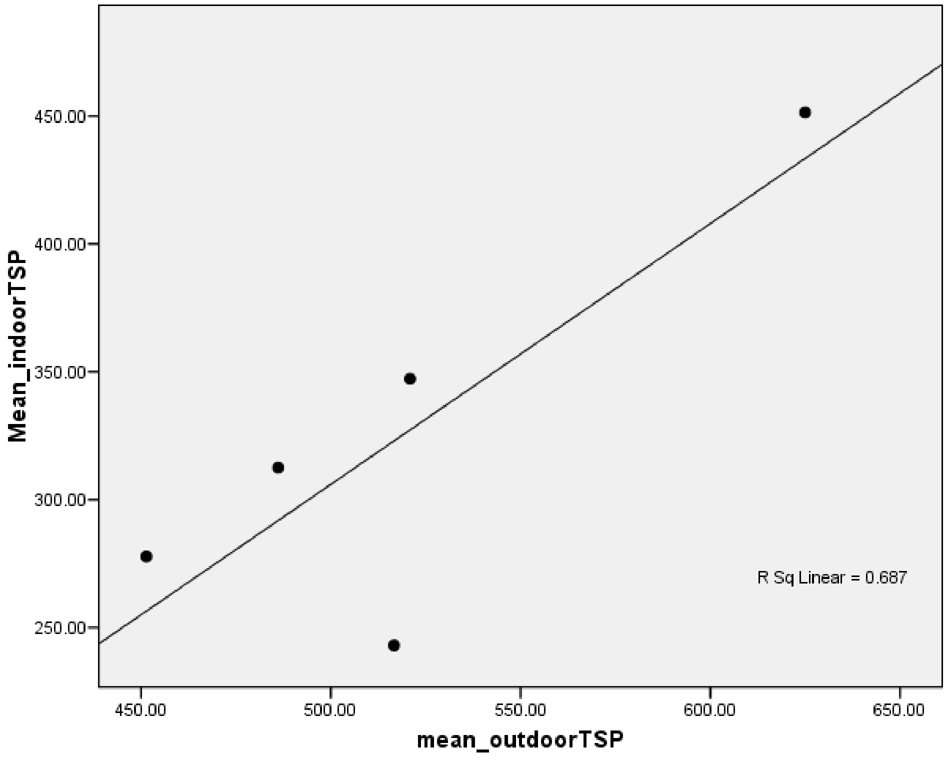

Figure 2.Correlation of mean indoor and outdoor TSP concentration in UBTH.(scatter plot)

CONCLUSION

The capture of outdoor and indoor particulate matter was done with a portable, programmable SKC Air Check. The highest outdoor mean concentration was recorded in site 2 and the lowest outdoor mean concentration was recorded in site 1. The indoor mean concentration, the highest mean was in site 3 while the lowest mean concentration was observed in site 4.

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