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MONITORING INDOOR CARBON-MONOXIDE (CO) LEVELS IN AGBOR, DELTA STATE NIGERIA TO PREVENT HIGH MORTALITY RATES FROM FUTURE PANDEMICS

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Abstract

Maintaining air quality is an important and effective approach to mitigating the virus pandemic in that, the quality of air is important in creating, sustaining or inhibiting conditions for virus viability. Polluted air is the most significant environmental risk factor for all-cause mortality. Exposure to poor air-quality may exacerbate symptoms, trigger a severe course of the virus and for the most vulnerable population, and eventually be fatal. The morbidity posed by air pollution and its impact on our current situation must not be overlooked in the midst of our unprecedented coronavirus pandemic. In-situ CO data from ten (10) shops at different locations in Agbor, Delta state, Nigeria were monitored between the hours 7.00am – 6.00pm thrice weekly for the period January to March, 2021 using BK PRECISION 627 carbon-monoxide sensor. Statistical correlations between the indoor and outdoor values were calculated. One of the main findings indicates high CO values in some of the shops. The Centre of Research on Clean Air reported that greater levels of air pollution interfere with the body's normal defense against air borne viruses including SARS-CoV-2. The findings suggest a potential for local traffic management strategies to reduce ambient exposure, minimize exceedances of air quality standards for pollutants and, optimize ventilation based on occupancy and activity.

Key Words: *Pandemic, Agbor, Traffic, Sensor, Carbon-monoxide, Shops*

Introduction

When a bacterium or virus has the ability that causes an infection to spread widely and quickly it becomes a pandemic. The WHO (2020a) defined pandemic as a worldwide spread of a new illness and are distinguished by their geographical spread rather than the severity of the illness (Porta, 2014); and spreads beyond national borders and possibly worldwide. The direct health effects of pandemics can be devastating. During the medieval Black Death of the thirteenth century an estimated 30 –50 % of the European population perished (Dewitt, 2014). More recently the HIV/AIDS pandemic has killed more than 35 million persons since 1981 (WHO 2010). The NCDC, Nigeria report shows that as at 29th July 2021 the country has recorded 2,141 deaths from COVID-19 infections with a total of 172,821 confirmed cases. In other countries around the globe, findings indicate that as at the

20th of July 2020, Italy recorded more than 245,000 total confirmed cases and 35,107 deaths from COVID-19 (WHO, 2020b); most of which were distributed in the regions of Northern Italy, especially the Lombardy which is recognized as one of the most air polluted areas of Europe (EEA, 2019). In air borne transmission of Severe Acute Respiratory Syndrome Corona Virus-2 (SARS–CoV–2) and severity of COVID-19, polluted air seems to play a significant role (Domingo *et al*., 2020).

Aside from the threat of a pandemic, polluted indoor air has been shown to impair cognitive performance, create fatigue and discomfort, and even increase the risk of heart and lung disease. Air pollutants and respiratory viruses have complicated interactions in the ambient air, which can influence the virus's persistence in the air, in addition to their interactions with the body (Bourdrel *et al*., 2021). The body immune system is weakened when we experience chronic respiratory stress due to pollution that may act as a vehicle for transmitting the vector (Domingo *et al*. 2020).

Study evidence (Cohen *et al*., 2017; Dehghani *et al*., 2017; Ali and Islam, 2020) indicates that both short and long term exposures to air pollutants are associated with a wide range of adverse health effects such as higher fatality rates, increased outpatient visits, etc. It has been reported that more than 8 million people each year die prematurely because of air pollution (Lelieveld *et al*., 2019) and findings suggests that people exposed to chronic greater levels of air pollution might be more vulnerable to viral infections (Travaglio *et al.*, 2020; Ali and Islam, 2020).

In Agbor there have been little or no exposure studies on indoor and outdoor carbon monoxide levels (Uche and Ukpebor, 2010). Indoor air pollution has diverse effects on people that are exposed, depending on body constitution, lifestyle, nutritional status and age. Generally speaking, older people and children are more sensitive to air pollutants (Jones, 1999). Most people spend a large part of their time indoors, which makes indoor spaces important microenvironments when addressing risks from air pollution. Exposure time and dosage of CO are risk factors that determine the severity of its effect on the population (WHO, 2010; Reboul, 2012, Onodera *et al*., 2016). Carbon monoxide is the most abundant and widely distributed air pollutant found in the atmosphere due to man's technological inventions, however no standard for CO indoor has been agreed upon; outdoor standards are 10ppm for 8hours and 35ppm for 1 hour (WHO, 2010). Carbon monoxide is a colourless, odourless and non-irritating gaseous pollutant (Langston *et al*., 2010) produced as a by-product of incomplete combustion of carbonaceous materials. CO concentrations are spatially heterogeneous within a city, with higher concentrations on busy roads and especially in street canyons. CO is one of the few contaminants in the environment that has a biologically hazardous form, carboxyhaemoglobin (COHb). CO has a higher affinity for haemoglobin than it does for oxygen, therefore the two combine to create carboxyhaemoglobin, a relatively stable complex (COHb). The presence of COHb in the blood decreases the blood's oxygen carrying capacity and restricts bodily tissues' access to oxygen resulting in tissue hypoxia (Ogunseye, 2018). A level of 50% carboxyhaemoglobin may result in seizure, coma, and fatality. The most typical symptoms of carbon monoxide poisoning include headache, nausea, vomiting, dizziness, fatigue, and a sensation of weakness, which are similar to those of other poisonings and diseases (Kayode and Feyisayo, 2013). Gas stoves, generators, and other gasoline-powered equipment, as well as automotive exhaust, tobacco smoke, and biomass burning, are all sources of indoor CO (WHO, 2010).

Since clean air plays a role in reducing the effects of respiratory and other form of illnesses, this study aimed at accessing indoor CO levels a regulated pollutant that has a primary emission source, so as to resolve issues proactively as an important and effective approach to mitigating future pandemic.

Material and Methods

Study Area

This study was conducted in Agbor Delta State, Nigeria. Agbor is the headquarters of Ika-South Local Government Area of Delta-State and lies within Latitude 6° 43′N and 6° 30′N and Longitude 6° 20′E and 6° 12′E. Agbor, an emerging city, is a commercial transitory town for commuters travelling to the North, East and Western parts of Nigeria (Uche and Ukpebor, 2010). The climate of Agbor is tropical with two major seasons, wet (April- September) and dry (October – March). Rainfall is bimodal, peaking usually in July and September. The mean annual rainfall ranges between 2000-2300mm. The mean relative humidity is about 70% while the average temperature is about 32°C.

Table 1: Sampling Sites, Description and their Coordinates

s/n	Shop Code	Co-ordinates	Site Description
1.	A	N 06° 15'57.5" E 006°11'12.1"	Site created at Uromi motor park; a busy junction with large number of trucks, buses, cars, motor-bikes, mechanic workshops and human traffic.
2.	B	N 06° 15' 40.3" E 006° 10' 09.0"	Site created along Obi- ikechukwu road.
3.	C	N 06° 15'15.0" E 006° 10'52.0"	Site located at popular College junction Agbor.
4.	D	N 06° 15' 14.3" E 006° 11'34.0"	This site is characterized by an intersection of roads, 4-junction (traffic light)
5.	E	N 06° 15' 03.7" E 006° 11' 38.3"	Site located around a busy market characterized by high buildings and narrow streets. This zone is particularly exposed to emissions from light vehicles.
6.	F	N06° 15' 32.5" E 006° 11' 38.7"	Site located around a busy Plank market
7.	G	N 06° 14' 38.2" E006° 12' 44.9"	Site located along owa-ekei road
8.	H	N06° 15' 11.3" E006° 12' 10.4"	CTC market
9.	I	N06° 14' 52.8" E006° 11' 43.0"	This site is located some distance at an intersection between two roads at the central area of the town.
10.	J	N06° 15' 25.1" E 006° 12' 33.4"	A quiet residential area with gardens and cultivated lands (DDPA)

Carbon-monoxide (CO) Measurement

Ten (10) shops/business centres were selected from ten different locations within the Agbor metropolis for the indoor monitoring based on congestion within the area, commercial activities, presence of motor parks/markets, nature of building and distance from the road. The aim is to target shops situated along or within the vicinity suspected to have indoor air quality problems. Measurement was conducted between the hours 7.00am – 6.00pm thrice weekly for the months January, February and March, 2021, using a BK PRECISION 627 carbon monoxide meter. The BK Precision 627 carbon monoxide meter is a portable, compact size digital meter that measures CO levels within the range 0 – 1000ppm. It has an accuracy of ±5%, operating temperature of 0 – 40°C and 15 to 90% relative humidity.

The instrument is equipped with a sensor which has an electrochemical sensing electrode and a counter electrode. The sensor has a permanent irreplaceable filter built inside the sensor to filter out trace concentrations of SO_2, NO_2 and most hydrocarbons. The catalytic sensor consumes no chemicals and detects changes in CO levels within a response time of less than 70secs. CO gas diffusing into the sensor reacts with the special catalyzed sensing electrode to produce electrons. A built-in circuit amplifies the signal into a millivolt output which is displayed on a liquid crystal display (LCD) panel in front of the instrument as CO concentration in ppm. The CO sensor was calibrated before deployment and during the monitoring exercise by ensuring that the zero and span of the dosimeter were checked at regular intervals using zero air and a standard CO concentration. The outdoor sampling was carried out at the same time as the indoor sampling with the outdoor ambient sites less than 50m from each sampled shop/business centre. This sampling approach has been used by several authors (Osuntogun, 2004; Wan-Kuen and Joon-Yeob, 2006; Uche and Ukpebor, 2010) because of the following positive attributes:

i. low cost
ii. high accuracy and sensitivity
iii. no special training before usage
iv. results instantly available
v. wide spatial coverage
vi. Its independence on electricity

Results and Discussion

Indoor air quality monitoring is the process of tracking pollutant levels overtime. The goal of collecting this data is to identify trends, spot problem areas and make adjustments accordingly. Indoor CO Concentrations (Figure 1) in shops varied from 2.31 – 9.13ppm. Highest indoor CO level for the three months (January, February and March, 2021) were recorded in shops sited in locations **A** (7.46, 9.13, & 8.10ppm) and; **D** (8.66, 7.83 & 8.47ppm) while consistently low values were recorded for shops in locations **I** (5.44, 3.62 & 2.68ppm) and **J** (5.00, 3.00 & 2.31ppm) for the respective months. Shop **D** is located along the ever-busy old Lagos/Asaba road (4–junction) with high traffic density; within the vicinity of the traffic light commuters do not obey traffic signs thereby causing lockjams and increasing the amount of emitted CO from stationery vehicles that are dispersed by winds into these shops that are located close to the road.

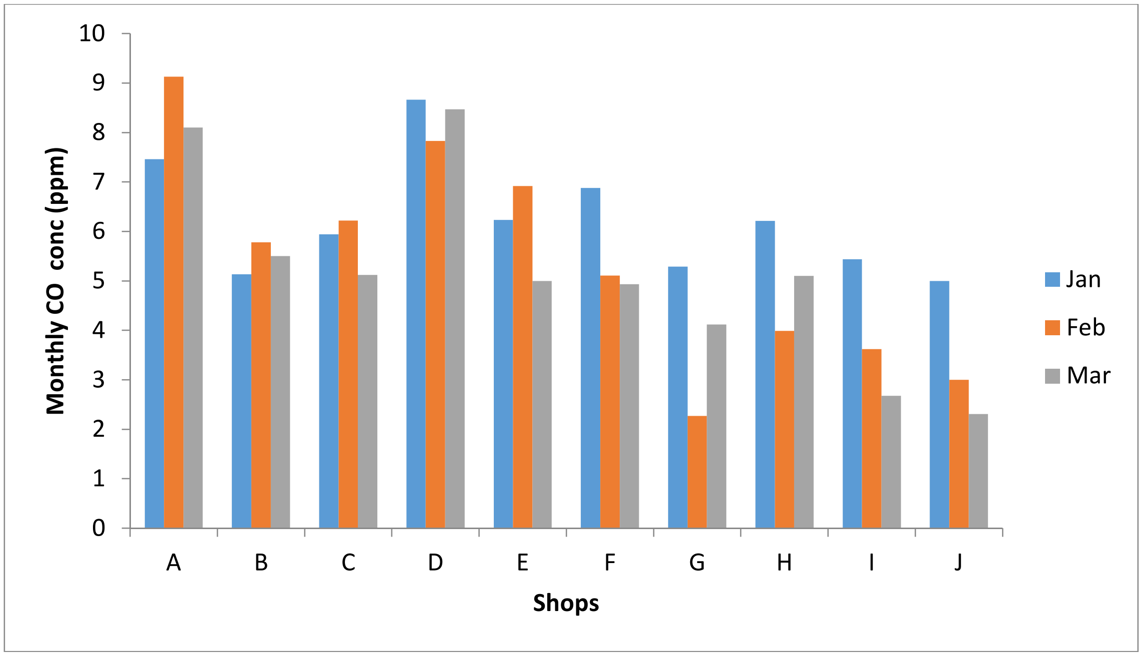

Fig. 1: Monthly Indoor CO concentration in shops

The mean CO levels (figure 2) recorded ranged between 3.44 – 8.33ppm and are lower than 12 – 33ppm values recorded (Rim-Rukeh, 2015) for squatter settlements in Warri; and also lower than 11ppm reported by Dehghanzadeh *et al.* (2013) for major commercial areas in Tabriz; a city in Iran. The values are also below the regulatory limits set by the World Health Organisation of 10ppm 8 hourly average. These values obtained is an indication that all is not fine as long exposure to lower amounts of carbon monoxide has significantly more serious health consequences than acute CO exposure. Hundreds of millions, if not billions, of people are currently chronically exposed to CO indoors around the world. According to the World Health Organization (WHO, 2010), such exposure can affect one's health in a variety of ways, including physical symptoms, sensory-motor alterations, mental health, cardiac events and low birth weights.

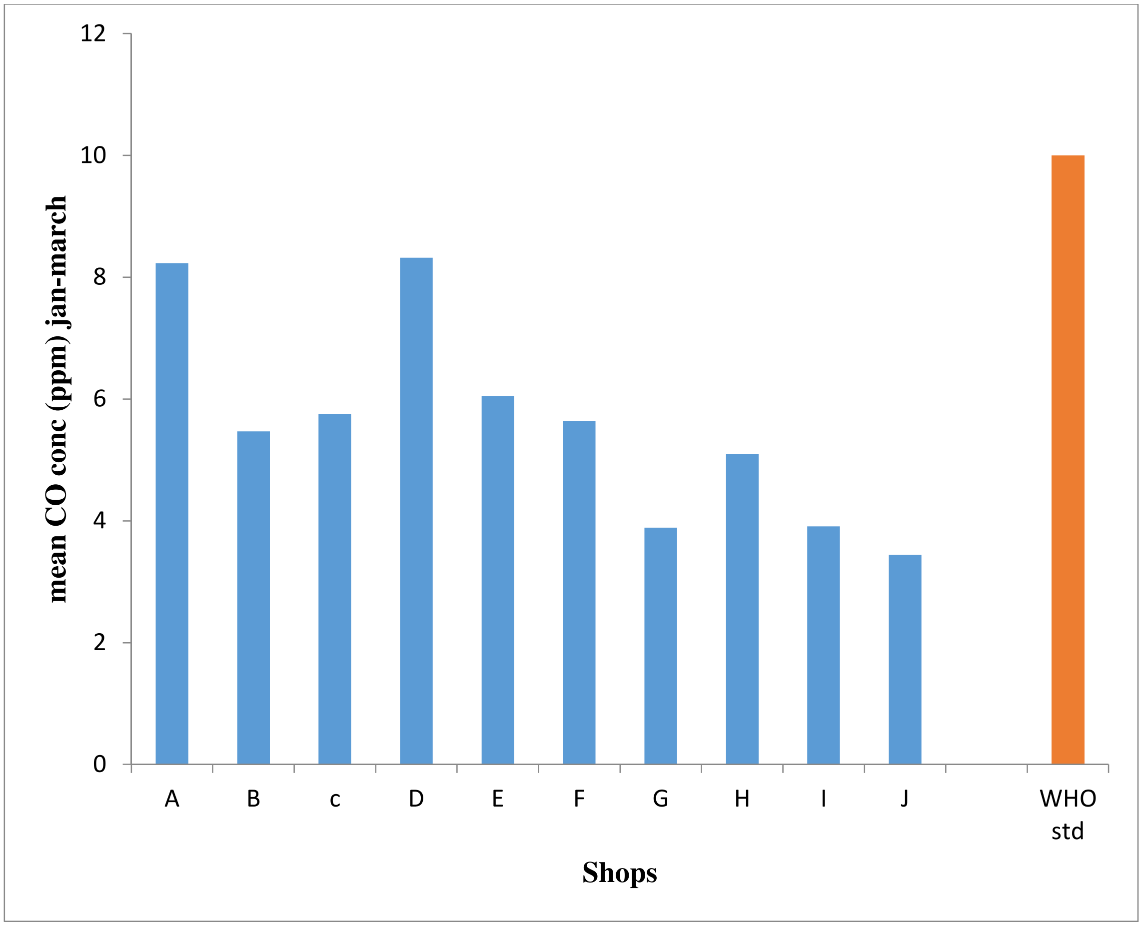

Fig. 2: Mean Indoor CO levels (ppm) Compared with International standard

Outdoor (ambient) values (figure 3) were slightly higher than indoor values. Apart from traffic, there are no major industrial sources of CO in Agbor. The correlation (Figure 4) between indoor and outdoor were highly significant (R^2 = 0.933). The indoor/outdoor ratio is less than unity, which explains that the major source of CO in the shops were traffic related.

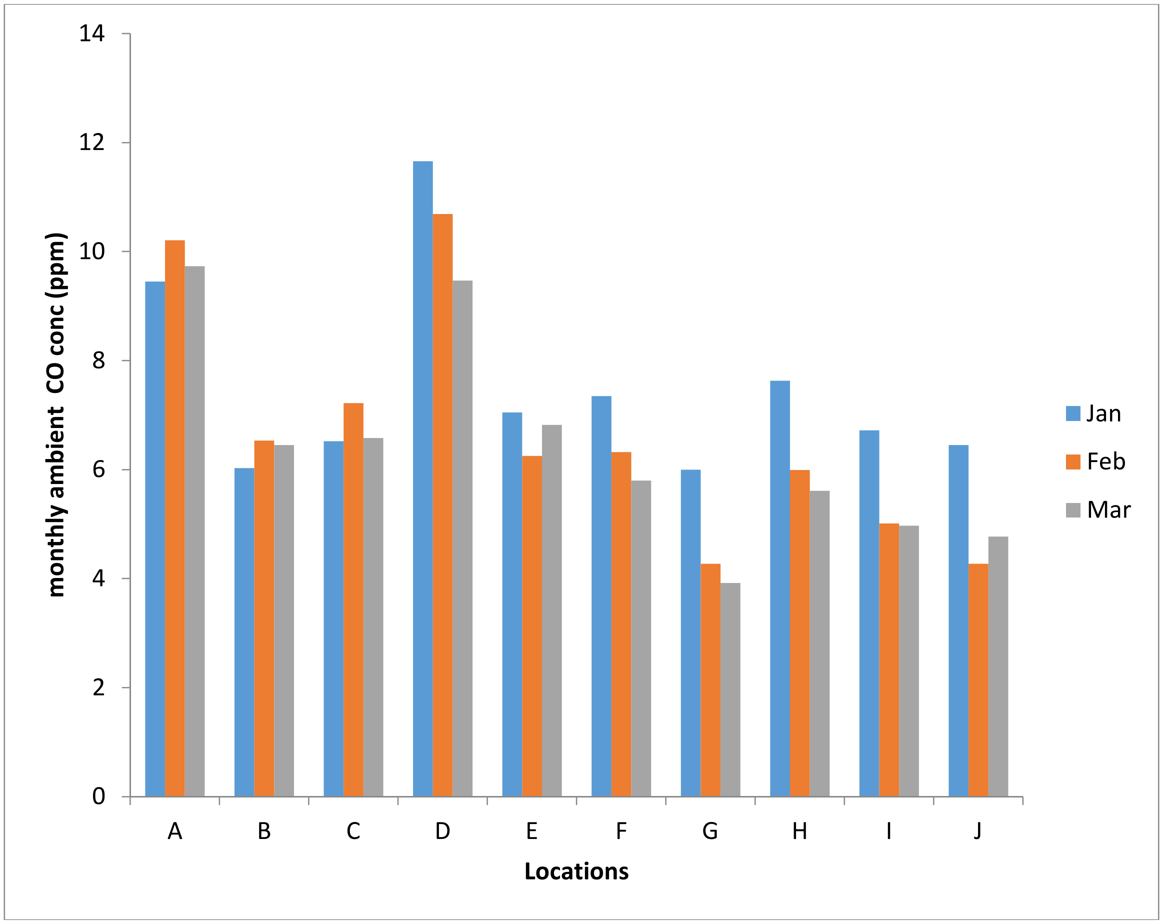

Fig. 3: Ambient CO levels for the locations.

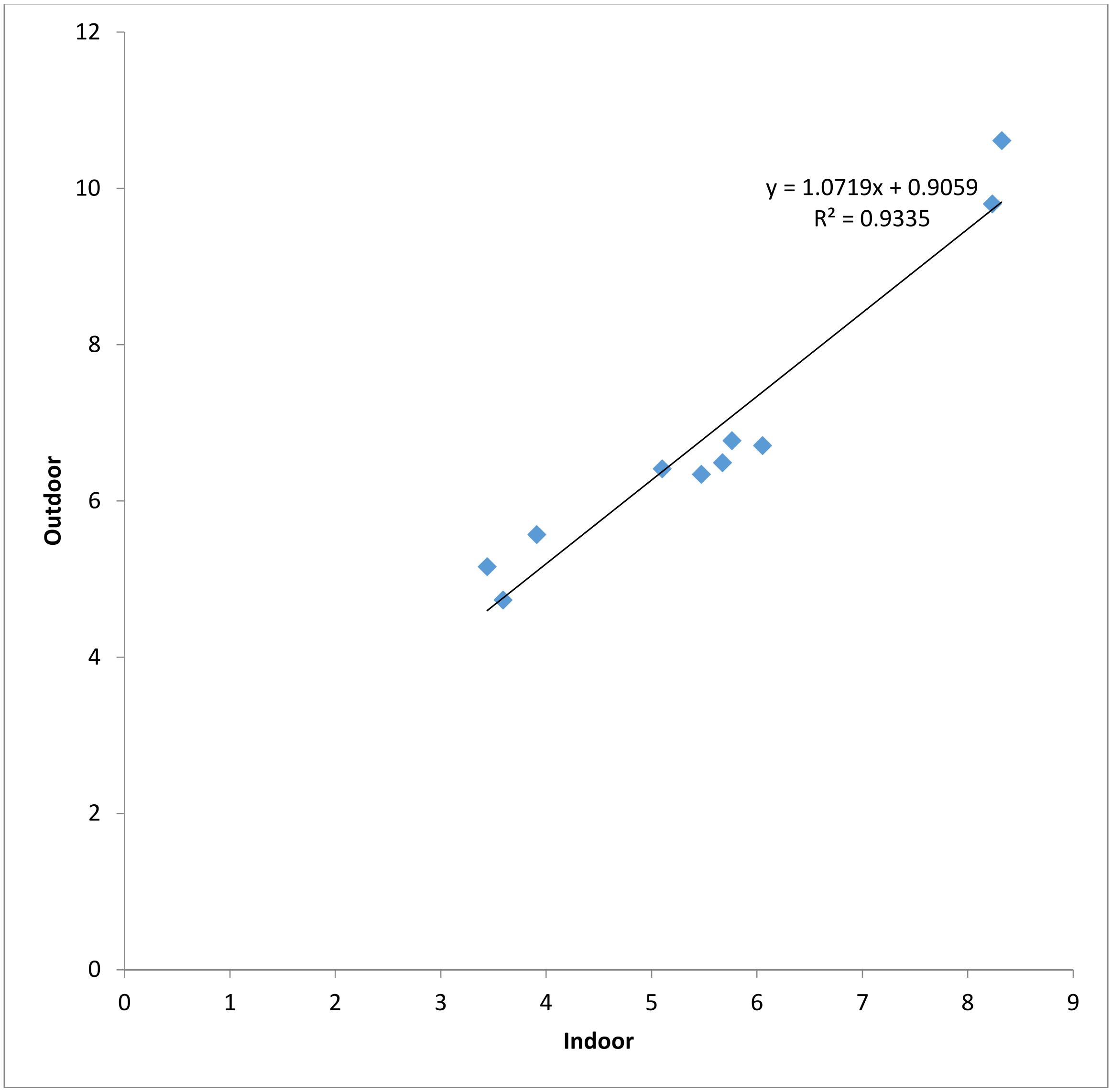

Fig. 4: Correlation between Indoor/Outdoor CO levels

Conclusion

Findings show that most of the monitored shops/business centres had poor ventilation system and concentrations were found to be higher where there are high traffic and occupant densities. The measured levels of indoor CO in the shops were gradually approaching the regulatory limits in many of the shops. Long term exposure to low doses of CO might weaken the immune system of persons (traders) who spend longer time in the shop. Indoor levels of CO are a function of both indoor and outdoor sources. Clean air is required to mitigate the virus impact that cause diseases and therefore;

- ✓ good air exchange rates through proper ventilation in indoor environments should be encouraged.
- ✓ Government should pay attention on the planning of the city and

- ✓ develop new technologies that would help reduce the levels of air pollutants create general awareness on the adverse health effects of CO.
- ✓ Public health policy that calls for reduction of pollution from traffic related sources should be enforced.

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