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High Carbon Monoxide Concentration Associated to Low Lungs Functions: Metrologic Study in Alkamleen Area, Sudan 2014 - 2016

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ABSTRACT

Carbon monoxide poisoning an important cause of accidental injury worldwide, and hazards to health, causes many damages in body system. This study was conducted in Al kamleen area where a lot of red brick factories are located along the Blue Nile river bank in the east of the area. The study aimed to investigate PEF at a high CO concentration area. the study area was divided by two lines parallel to the river bank, 500 meters distance from each other into three zones A, B and C from north to south. Also it was divided from east to west by five imaginary lines to give six squires in each zone. The reading for CO concentration was determined for each square. PEF value determined by using PEF fluemeter across summer and winter. CO in air was found to be significantly higher levels of CO concentration in air were detected throughout the year in all zones. PEF values of study group significantly lower than references data and control group; in winter Mean ± SDwere420.4±88.7 and references 552.0±83.1, a reduction to the references was 63.8%. In summer Mean ± SD were 414.0±86.2 and references were 549.0±85, a reduction to the references was 24.6%. The Mean ± SD of control group were 468.4±77.4.The reduction in PEF for study group in winter as compared to the reference were 10.3% and for summer were 11.5% air CO was significantly exceeds the WHO recommended standards. Lower PEF value in study group in winter and summer were associated to high CO concentration which emitted from red brick kilns in Alkamleen area.

Introduction

The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution, Carbon monoxide (CO) poisoning is responsible for up to 40,000 emergency department visits and 5000 to 6000 deaths per year, making it one of the leading causes of poisoning death in the United States.[1]

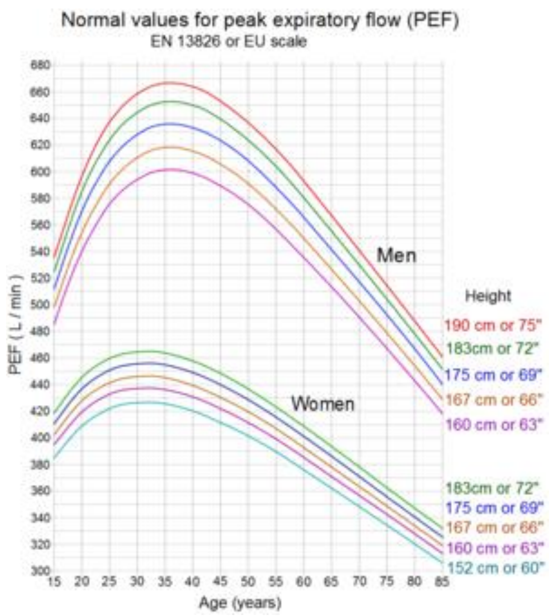
Carbon monoxide is a product of incomplete combustion of organic matter due to insufficient oxygen supply to enable complete oxidation to carbon dioxide (CO2). Natural background carbon monoxide concentrations average around 0.05 mg/m3 (0.04 ppm). [2, 3, 4]

Metrological factor effect in CO concentration in air therefore in some studies found that a concentration of three pollutants are inversely proportional to wind speed and wind direction, these factors are distributing carbon monoxide in air and can take it far away. Temperatures and humidity also effect on CO concentration.[5]

The toxicity of CO is a result of high affinity of Hb for CO which is 200 – 250 times that for oxygen. In addition to that CO affinity for myoglobin is about 60 times greater than that of oxygen, which cause reduction in oxygen-carrying capacity of the blood. [2’ 3]

Chronic inhalation of polluted air with carbon monoxide leads to oxygen deprivation, asphyxiation and shortness of breath. This causes respiratory insufficiency leading to lung destruction and obstructive pulmonary disease. [6, 7]

Assessment of lung function is determined by measurement of the peak expiratory flow (PEF) in liters/minute. The reference values of PEF are determined by age, gender and height [8] as appear in the figure below.[9]



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To our knowledge there are limited studies on the effects of chronic exposure to CO and PEF values. Some studies correlated low PEF with high frequency of smoking[10] as well as among grills workers, observed that chronically exposed to CO reduces the PEF values. [11]

Epidemiological studies have examined possible associations between ambient air carbon monoxide concentrations and mortality. **Collectively, these studies have yielded mixed results, with some studies finding** significant associations between increasing ambient air carbon monoxide concentrations and respiratory outcomes (e.g., exacerbation of asthma symptoms, hospitalizations and emergency room visits related to asthma). [12.]

Objective

This study aimed to investigate the correlation of high CO in air around red brick factories across seasons with changes in PEF value among the habitant compared to control area free of kilns in Alkamleen area, central Sudan

Materials and Methods

Materials

This study is a cross- sectional descriptions analytic study.

Area of the study; the study was done in Alkamleen, Gazeera State, Central Sudan; it is located at the intersection of the latitude 15.23 degrees north and longitude 11.33 degrees east[13,.]. The area was mapped as follows:

Study Area (area 1)

The area was determined from north to south along the western bank of the Blue Nile, where the redbrick kilns (source of smoke) were located. The distance was found to be three kilometers. The width was determined from east to west starting from the bank of the river and was found to be1.5 kilometer. According to carbon monoxide concentration which was high near the source, then declines while moving west till the sensitivity of the sensor reached the lowest limit and this measured was 6ppmWhich was equivalent to zero level.

Eventually this area was divided by two lines parallel to the river bank to give three horizontal zones (A,B and C) the distance between the lines was 500 meters. In east – west direction the area was divided by five imaginary lines with 500 meters apart to give six squires in each zone as seen in the diagram below.

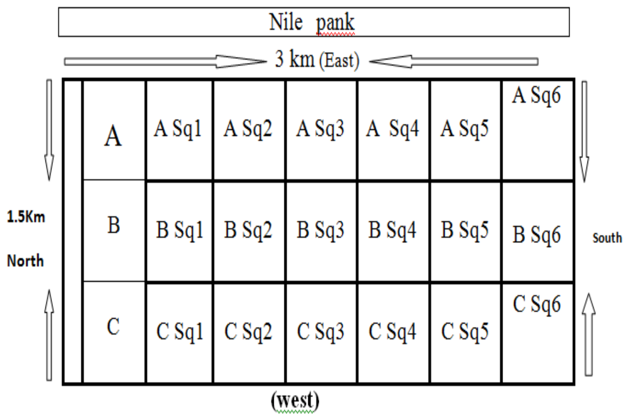

Fig 1. Diagram showing the croaky of the study area into zones and squires

Control Area (Area 2)

This area was delineated by horizontal line one kilometer west to the high way which was about three kilometers to the west of area one.

Population of the study

The study was performed on people living close to traditional kilns. Those are the families lived in this area for the last 90 years or more. It worthwhile to mention that they were living in this area before the kilns was established. The kilns were being known for the last 60 years.

Fig 2. location of the study area in Google map with a croaky of zones and squires.

Inclusion criteria: The participant were living in the study area (area one for the study group and area two for the control group) at the time of the study.

Exclusion criteria

Smokers, bakers and patients who were known cases of blood disorder. Also those who lives outside the delineated areas.

Recruitment of population

Request for participation in the study was announced to the public via the local authority.

Ethical clearance and consent

The study had been approved by the ethical committee of the university. The consent had been obtained from each volunteer after explanation of the procedure.

Methods

CO measurement in air

The tests were performed by spectrometer. The spectrometer as in fig.(3.3) was prepared and raised to height of 3 meters for 5 seconds. The reading for CO concentration, wind speed and humidity were then reported. The readings were repeated three times with an interval of 1 minute. The average reading was then determined. This step repeats five times to each square. The lower limit of sensitivity of the apparatus was 6 parts per million (ppm). This was considered as zero level

Conforms to the European Standard EN 50543
and British Standard BS 6173:2009

The high-quality testo 315-3 is an easy-to-use, ruggedly designed. CO and CO2 monitor that enables to carry out quick and reliable ambient measurements and allows temperature, humidity and wind speed measurements.

Metrological factors data

The reference for the weather climate data was obtained from Meterological Authority in Sudan2013 (see appendix).

The data included were CO concentration on air, temperature, humidity, wind direction and wind speed.

The PEF was measured as follows:

1. The PEF measurement device (PEF meter) was set at zero.
2. The participants take full inspiration and make full expiration in a cup attached to the PEF meter.
3. The peak force of expiration (PEF) was then determined.
4. The maneuver was repeated three times and the highest value was recorded.

The Original Wright Peak Flow Meter

Results

Table 1. The Meteorological Data in both Areas 1 and 2 at summer and winter*

No	Item	Winter	Summer
1	Wind direction	North	South west
2	Temperature	34.9 ^{0}C	43.1^{0}C
3	Humidity	29	26
4	Wind speed	5X10^6	5X10^6

**the readings were found to be similar to reports of Weather Climate Data-Meteorological Authority (see appendix).*

Table 2. Level of CO Concentration across all Zones in Winter &Summer

Zones	CO Conc. During winter	CO conc. During Summer	S.E±	t. value	Sig.
A	104.2	76.6	14.2	2.6	*
B	54.8	48.4	8.1	0.79	Ns
C	18.9	13.9	2.5	2.04	*
Mean	59.3	46.3	7.1	1.83	Ns

ns: not significant

**: significant at 0.05 level of probability.*

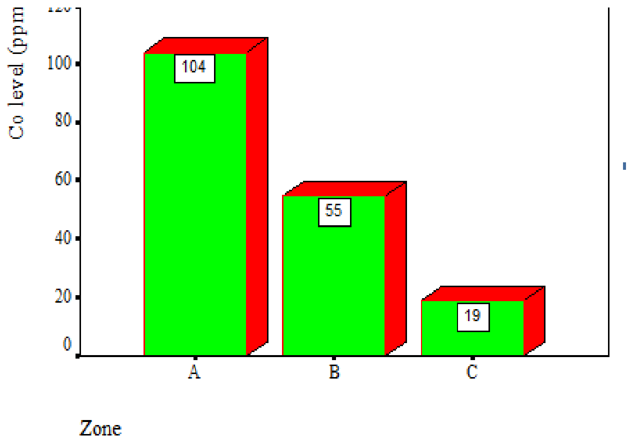

Fig 3. CO Concentration during winter at all Zones.

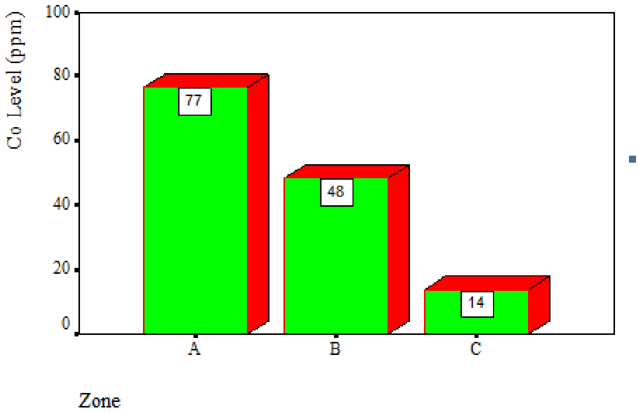

Fig 4. CO Concentration during summer at all Zones.

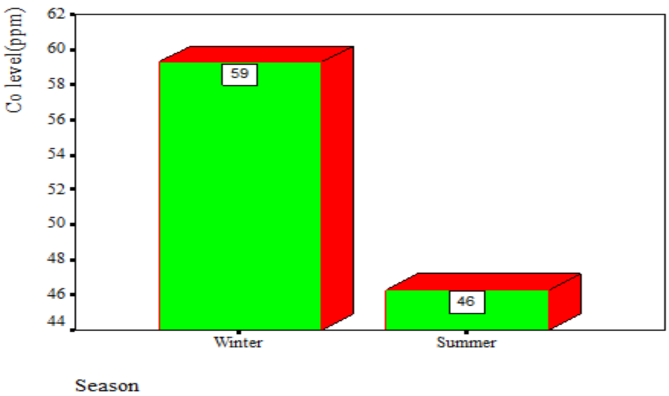

Fig 5. CO Conc. in winter and summer at Study Area

PEF findings during winter and summer

Table 3. Descriptive Statistics Showed the Mean of PEF Data for Study Group in Winter for Reference and Control Group

Variables	Minimum	Maximum	Mean ± SD
Winter PEF	280.00	600.00	420.4±88.7
Reference PEF	405.00	655.01	552.0±83.1
Control PEF	300.00	850.00	468.4±77.4

Table 4. Descriptive Statistics Showed the Minimum, Maximum and Mean of PEF Data for Study Group in Summer, Reference and Control Group

Variables	Minimum	Maximum	Mean ± SD
Summer PEF	280	600	414.0±86.2
Reference PEF	400	653	549.0±85.0
Control PEF	300	850	468.4±77.4

PEF findings for study group and reference value

Table 5. Comparison between PEF Data of the Reference and Study Group in Winter.

Parameter	Winter	Reference	d.f	S.E±	t.value	Sig.
PEF	420.4	552.00	98	17.2	7.66	**

**: significant at 0.01 level of probability.

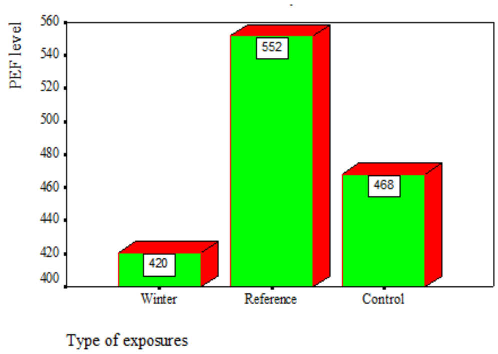

Fig 6. Comparison between PEF Data of the Control Group, Reference and Study Group in Winter

Table 6. Comparison between PEF Data Of The Reference And Study Group In Summer.

Parameter	Summer	Reference	d.f	S.E±	t. value	Sig.
PEF	414	549	98	17.2	7.79	**

**: significant at 0.01 level of probability.

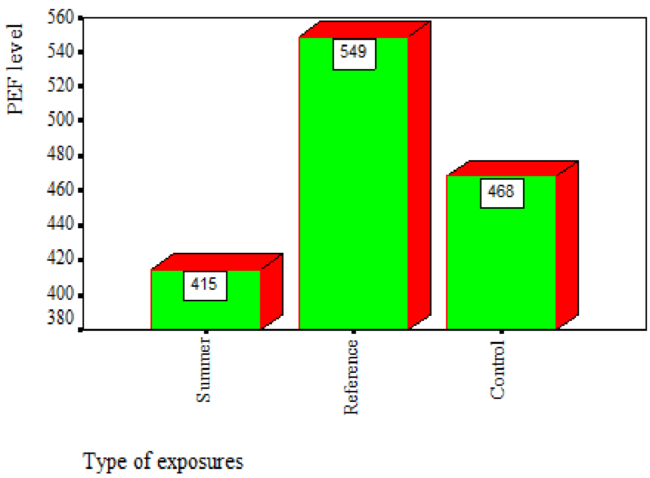

Fig 7. Comparison between PEF Data of The Control Group, Reference and Study Group in Summer.

PEF data for study group and control group

Table 7. Comparison between PEF parameters of Study Group in Winter and Control Group.

Parameter	Winter	Control	d.f	S.E±	t.value	Sig.
PEF	420.4	468.4	98	16.6	2.88	**

**: Significant at 0.01 level of probability.

Table 8. Comparison between PEF parameters of Control Group and Study Group in Summer.

Parameter	Summer	Control	d.f	S.E±	t. value	Sig.
PEF	414	468.4	98	16.5	3.25	**

**: Significant at 0.01 level of probability.

PEF data for study group gender

Table 9.Comparison Between PEF Data For Male And Female At Study Group In Winter.

Parameter	Male	Female	d.f	S.E±	t.value	Sig.
PEF	432.4	395.0	48	26.6	1.40	Ns

ns:not significant.

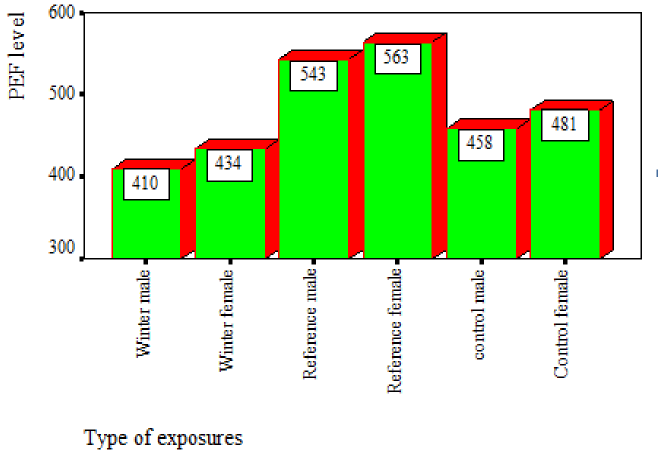

Fig 8. Comparison of PEF Data at (Winter, Reference and Control Group) to the Gender.

Table 10. Comparison between PEF findings for Male and Female at Study Group in Summer

Paramecia	Male	Female	d.f	S.E±	t. value	Sig.
PEF	438.6	359.3	48	24.7	3.21	**

**: significant at 0.01 level of probability.

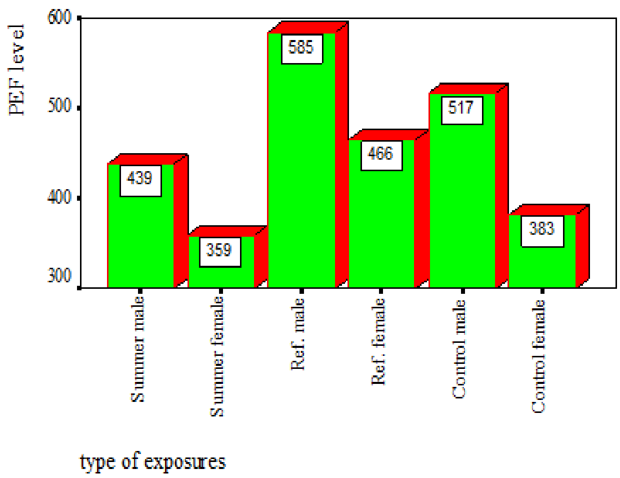

Fig 9. Comparison of PEF Data at (Summer, Reference and Control Group) to the Gender.

Comparison of PEF data in winter and summer for study group

Table 11. Comparison between PEF Data across Season at Study Group

Parameter	Winter	Summer	d.f	S.E±	t.value	Sig.
PEF	420.4	414.8	98	17.6	0.32	Ns

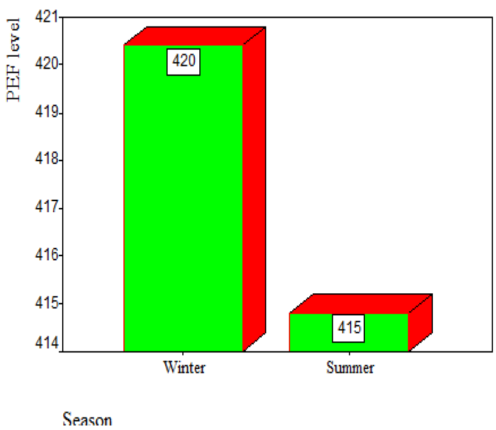

Fig 10 . Comparison of PEF Data at Summer and Winter.

Discussion

The present study was designed to investigate the level of Co pollutant emitted from the red-bricks nil and its outcomes at Alkamleen region (North Gezira state and 130 km away from Khartoum) during winter and summer 2012/3013 season. The measurements of Co levels were realized immediately near the emitted sources (500m distance apart) as well as three residential locations near the six sources.

Significantly higher levels of CO concentration in air were detected throughout the year in all zones.

Wind direction had a clear effect on CO concentration in air. This was evident by detection of high level of concentration during winter in the southern squares (sq5 and 6), when the direction of wind was from north to south, while it was low during summer season when it was in the opposite direction. Another factor which affected air concentration was the distance from the source of CO the study showed higher readings in zone A compared to zone C in both winter and summer and steady readings in zone B. it worth mentioning that the levels of emitted CO violated the WHO standards during both winter and summer seasons. This agreed with results reported by researchers like Odat (2009).[(14)] and Alkama *etal*, (2008) [(15)] who showed that pollutant disperses away from the source of discharge and the wood work until the lower level of the sensor sensitivity (6ppm) was reached. The decrease of CO follows an exponential shape according to distances. Hence it was found beyond doubt that living near the source of CO is directly correlated to air level concentration.

Peak expiratory flow, which used to measure the range of great airway obstruction, was applied in both winter and summer for the study group and the collected data was then compared to reference PEF and control PEF. Comparison between male and female was also carried out.

In the study group the PEF did not show statistical significant difference across seasons. However comparing the study group with the control group and the reference values a significant reduction in the PEF among the study group was detected (P<0.01). Reduction of PEF among the control group compared to the reference values was found to be similar to the report of a study done in central Sudan by Abdelaziz, O et al[16].

This may point to a correlation between increase CO air level and reduced PEF value hence liability to develop obstructive pulmonary disease. The current findings were in agreement with the famous study performed in a furnaceman (grill kebab chiefs) conducted by B. Bakki *etal*., (2012)[17], and Behçet Al1 et,al (2012)[18].Their result in PEF values among the study group was lower than control group and lower than reference value.

Although the study group showed significant presence of asthma like symptoms (wheezes and cough) yet this is not of a strong evidence for correlation of CO air pollution and asthma. This debate of association between ambient air carbon monoxide concentrations and asthma symptoms (eg, coughing, wheezing, chest tightness, shortness of breath, in hale ruse) was investigated by many workers (Yu *etal*., 2000, Vonklot *etal*., 2002, Slaughter *etal*., 2003, Rabino vitch *etal*., 2004, Park *etal*., (2005), Schildcrout *etal*., 2006, and Rodriguez *etal*., 2007).[(3, 4)].

Their findings provided evidence for association between increasing air carbon monoxide and increasing severity of asthma. However, Vesely *etal*., (2004) mentioned that although cardiopulmonary arrest is an end point of risk carbon monoxide poisoning, results of controlled clinical studies in healthy subjects indicated that respiratory tract does not appear to be a primary target organ for carbon monoxide toxicity. Therefore it is difficult to sort out the effect of CO from those of other urban air pollutants that have strong correlation with air CO concentration and that also could have affected pulmonary function. Al, B. Yildirim, C (2009). [(11)]. pointed out that's the higher the CO Hb level resulted in higher difference (relationship) between measured PEF values and the reference PEF values Park *etal*., (2005)[19]showed that CO was significantly associated with PEF.

Peak expiratory flow in this study was significantly lower among female in the study group in summer compared to male. This could be attributed to the fact that females tended to stay indoors for a period more than males who go outdoors for work every day for not less than 8 hours per day on daily basis.

Conclusions

The result of this study can be summarized as follows:

1.Red brick kilns are major sources of CO pollution. Concentration of carbon monoxide near the sources and surrounding zones was significantly higher depending on wind direction and intensity of emitted gases.

2.CO pollution is highly correlated to reduced PEF values.

3. Concentration of CO in chemical productive regions must be measured, so that protective measures should be adopted by the workers.

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