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Original Research Article

A Study of Determination of Exhaled Carbon Monoxide and Carboxyhemoglobin in School Children

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Abstract

Background: carbon monoxide (CO) may play a role in pathophysiology of airway diseases. School children are at risk of exposure to environmental smoke. Adequate data regarding are not available. The measurement of exhaled CO level may provide an immediate, non-invasive method of fractional concentrations of CO in expired air. Exhaled CO levels & Carboxyhaemoglobin (COHb) reflects the exposure to environmental smoke.
Aim: Hence, this study was done to investigate whether school children are exposed to environmental pollution by measuring the exhaled COHb and CO levels.
Method: 654 school children of North Chennai with 329 clinically normal girls and 329 boys of age group 13 to 18 were included in the study. A single measure of CO was obtained with a CO CHECKPLUS machine. Exhaled CO levels in ppm and equivalent COHb in % are recorded at the same time.
Results: The mean exhaled CO concentration and mean carboxyhaemoglobin (COHb) are not significantly changed in school children. The boys showed a significant ($p<0.01$) elevated mean exhaled CO concentration and mean carboxyhaemoglobin (COHb) levels than girls.
Conclusion: The increased exhaled CO level in school boys than girls may be due to social and behavioral reasons.
Keywords: Carbon Monoxide (CO), Carboxyhaemoglobin (COHb), School children.

1. Introduction

Carbon Monoxide (CO) is often called the “Silent Killer” because of its ability to take lives quickly and quietly when its victims never even knew they were at risk. Carbon monoxide is a colorless, odorless, and tasteless gas which is therefore very difficult to detect [1]. The sources of CO polluting the environmental air could arise from clogged fireplaces, chimneys , cigarette smoke and any gas or propane based engine will produce CO, like motor bikes, trucks, and small aircraft as soon as they start their vehicle.

CO may play a role in pathophysiology of airway diseases. CO has been recovered in exhaled air from normal subjects and at higher levels from the exhaled air of patients with asthma.

Depending on the level of CO, and length of exposure, one may experience any one or more of the following symptoms: headache, dizziness, weakness and clumsiness, nausea and vomiting, quick irregular heartbeat, chest pain, hearing loss, blurry vision, and disorientation or confusion seizures. Most of us might have suffered these symptoms at least once but could not be due to CO poisoning. But suffering from these symptoms on regular basis should be taken into account of possibility of CO poisoning. And these symptoms would also be reported from the family members of those who have been sharing same environment that raises the suspicion of CO poisoning.

Milder symptoms even if unreported or not got sufficient attention, they could affect significantly the academic performances of school children along with the chronic unattended minor symptoms depending upon the tolerant behavior of some students and their other well being in different social occupancies [2,3]. Lower levels of CO exposure might be a health threat to the patients who are co morbid with ischemic heart disease and congestive heart failure. But our study included only school children, those having remote possibility of such morbid conditions specific for the old age like ischemic heart disease.

Slight headache (after 1-2 hours) can occur with exposure of 100 ppm and loss of consciousness at 1000 ppm depending on the hours of exposure. Maximum recommended indoor CO level is 9 ppm [4].

In school children such constant exposure to environmental pollutants can lead to decreased attention and academic performances. Significant exposure to CO can also reduce life expectancy. This toxic gas takes lives that could be saved through education, awareness, and simple protection.

Carboxyhaemoglobin (COHb) is closely linked to tobacco smoking, whereas passive smoking, traffic exhaust, industrial smoke and endogenous CO production is of relative minor importance [1]. The COHb level is determined by rates of absorption and elimination. The half-time is determined by the minute volume being 3–6 h at rest [5,6]. Exhaled CO correlates closely to COHb and is easily and reliably measured by hand-held breath analyzers [7-10]. The measurement of exhaled CO level and COHb may provide an immediate, non-invasive, cheap, quick, portable method of assessing fractional concentrations of CO in expired air. The aim of our study was to investigate levels of COHb and exhaled CO in school children and any gender difference in exhaled CO & COHb levels.

2. Materials and Methods

Background information about subject's health, age, gender, smoking habits, occupational state and passive smoking were obtained. Exposure to environmental tobacco smoke (ETS) was ascertained using data derived from the same questions asked to the subjects. A person was deemed to have been exposed to ETS if a household member had regularly smoked cigarettes in their presence or if a co-worker smoked in the same indoor room in their presence for more than one year during the past 10 years. The exhaled CO levels& COHb were measured in 654 school subjects including 329 boys and 329 girls of age group 13 to 18.

2.1 Breath CO monitoring

Exhaled CO concentration was measured using the CO check plus. This analyzer is reported to correlate closely with blood COHb concentration. The measurement of exhaled CO was done at school premises itself. The measure was expressed as parts per million (ppm). Participants are asked to exhale completely, then inhale fully, and then hold their breath for 15 seconds before exhaling rapidly into disposable mouthpiece. Ambient CO levels were recorded before each breath. Exhaled CO levels are recorded from digital monitor in ppm and equivalent COHb in % at the same time.

2.2 Statistics

All statistical analyses were done using SPSS v16.0 software. Results were expressed as mean & SD. Independent unpaired student 't' test was used to compare mean value of exhaled CO and COHb levels between groups. A P-value less than 0.05 was considered significant.

3. Results

Exhaled CO was detectable in all subjects. Breath CO levels were assessed in a total of 654 subjects. The mean exhaled CO concentration (in PPM) for girls was 1.22 and 1.39 for boys. The mean carboxyhaemoglobin (COHb) for girls was 0.22 % and 0.24% for boys. There was significant (p value <0.01) statistical difference in both exhaled CO and COHb % data between boys and girls.

Among 329 girls only two had value of exhaled CO 5 ppm, and 4 ppm. And 6 girls had 3 ppm rest of them having lesser than 3 ppm. Among 329 boys three had exhaled CO value 4ppm and 14 were having 3 ppm and rest of them recorded lesser than 3 ppm. Exposure to environmental smoke was reported in 27 boys and 9 girls. Exhaled CO was found to be higher in subjects exposed to environmental tobacco smoke.

Table 1: Comparison of mean Age between girls and boys

Group	Number of subjects	Age (Mean &SD)
Boys	329	15.08±1.96
Girls	329	15.45±1.06

Table 2: Comparison of CO Hb% between girls and boys

Variable	Group	Mean CO Hb%	SD	P -Value
CO Hb%	boys	0.24	0.08	0.003
	girls	0.22	0.07	
** P – Value < 0.01 Highly Significant				

Table 3: Comparison of EXHALED CO ppm between girls and boys

Variable	Group	Mean	SD	P -Value
EXHALED CO (ppm)	Boys	1.39	0.61	0.000
	girls	1.22	0.51	
** P – Value < 0.001 Very Highly Significant				

Table 4: CO ppm level and equivalent COHb % values

CO (ppm)	% COHb level
1	0.16
2	0.32
3	0.48
4	0.64
5	0.80
6	0.96
7	1.12
8	1.28
9	1.44
10	1.60
11	1.76
12	1.92
13	2.08
14	2.24
15	2.40
16	2.56
17	2.72
18	2.88
19	3.04
20	3.20
20 & above	3.20+

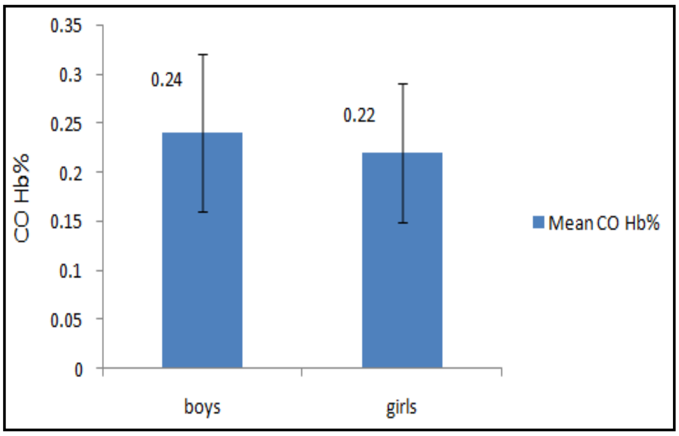

Figure 1: Comparison of CO Hb% between Boys and Girls

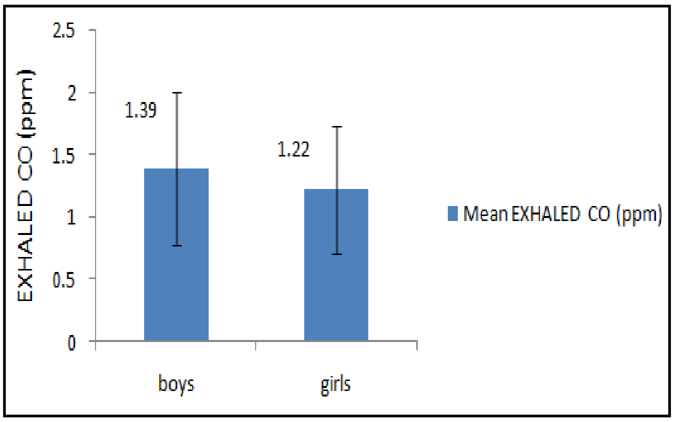

Figure 1: Comparison of EXHALED CO ppm between girls and boys

4. Discussion

In our study male subjects showed a statistically significant increase in exhaled CO concentration and COHb% in comparison with females may be due to constant exposure to air pollutants by outdoor, chats, and recreational activities. The chronic exposure to carbon monoxide in school children might cause headache, dizziness, weakness.

Though none of school children reported more than 6 ppm of reading, half time of COHb should also be taken into account. CO levels in the blood decline with a half-life of about 6 hours.

5. Conclusion

The normal concentration of carboxyhaemoglobin (COHb) does not disprove CO poisoning unless the sample has been taken soon after exposure ended. A heparinized venous blood sample should however, always be taken and sent to the local Clinical Chemistry Laboratory for analysis of COHb.

The exhaled CO recorded was remote from that one could expect clinical manifestations, this study creates a social alertness that school children though sharing a common environment in school premises, their exposure at home and while commuting might be a potential one to create such results. Raise of this exposure would be obvious if the study is further continued in future.

The use of CO recordings in clinical settings have so far been limited to validate claims of smoking cessation and to determine the severity of smoke exposure in victims of fire accidents. The measurements are easy to perform, noninvasive and cheap [11-14], it would be of clinical interest if a CO measure could provide an early indication for the school children at particular risk of developing CO poisoning

Hence hereby the study concludes the importance of prevention of exposure of carbon monoxide through air pollutants in school children by constant checking of exhaled CO concentration and COHb % level every quarterly.

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