

# Expired Air Carbon Monoxide Levels as a Marker of Passive Smoking In Pregnant Women

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## Abstract

**Background and Aim:** Smoking directly or indirectly has serious impact on health of an individual. During smoking various chemicals and toxic substances are released into the air such as nicotine, carbon monoxide which can be inhaled by the people nearby indirectly. Pregnant mothers may passively inhale carbon monoxide when exposed to such environment. Maternal Carbon monoxide passes through placenta and enters foetal blood combine with foetal haemoglobin forming foetal carboxy haemoglobin. Foetal carboxy haemoglobin in turn makes oxygen unavailable to foetal tissues which could be the reason for various poor outcomes in unborn foetus such as low birth weight, intra uterine growth retardation with higher rates of perinatal mortality. This study is aimed at measuring the expired air carbon monoxide levels in passively smoking pregnant women that can be correlated with exposure to passive smoking.

**Method and Materials:** 100 antenatal women of gestational age between 26 to 34 weeks with and without exposure to passive smoking were measured for carbon monoxide levels in their expired air using simple, portable non invasive carbon monoxide monitor.

**Statistical Analysis:** Data analysis was done with unpaired student t test. P value of <0.05 was taken to be significant.

**Results:** No significant statistical difference is observed between cases and control groups in expired air carbon monoxide levels.

**Discussion and Conclusion:** The lesser half life of carbon monoxide in exhaled air. The long time interval between the exposure and the time of testing, the metabolic changes associated with pregnancy could have made this test inconclusive. Though gold standard blood analytic method cannot be replaced by this breath monitors, it can be used as a simple portable noninvasive tool to educate pregnant women to avoid exposure to passive smoking.

**Keywords:** Expired air carbon monoxide, pregnant women, passive smokers, foetal carboxy haemoglobin.

## Introduction

According to the international consultation on environmental tobacco smoke (ETS) and child health,

maternal smoking is associated with many harmful effects on the outcome of unborn foetus. Low birth weight and growth retardation are common complications<sup>1</sup>. There is also 33% increase in perinatal mortality, 50% increase in idiopathic mental retardation. Other complications include sudden infant death syndrome<sup>2</sup>, attention deficit hyperactivity disorders and premature delivery. The components emitted during smoking cross the placenta and act as mutagens resulting in childhood cancers like acute lymphocytic leukemia and lymphoma<sup>3</sup>. In countries like India though maternal smoking is not as common

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as western countries indirect exposure to smoking is not uncommon. There is evidence that passively smoking pregnant women show harmful effects on outcome of pregnancy as those of smoking mothers. These include miscarriage, stillbirth, congenital malformations, low birth weight, intrauterine growth retardation, sudden infant death syndrome, and preterm delivery<sup>4</sup>.

The so called passive smoker inhale the side stream smoke arising from burning end of the cigarette which contributes to 85% of smoke present in the room. This side-stream smoke appears to have the lethal toxic gases in considerably higher concentrations than in the mainstream smoke<sup>5</sup>. Carbon monoxide and nicotine are the common gases emitted during smoking. On average 4% carbon monoxide is present in cigarette smoke<sup>6</sup>. In a smoke filled room a non smoker is exposed to 25-100 ppm carbon monoxide.

Carbon monoxide combines with maternal haemoglobin and form carboxy haemoglobin which in turn crosses the placenta and leads to foetal hypoxia. Nicotine in the smoke causes vasoconstriction aggravating foetal hypoxia. Nicotinic effects may be due to inappropriate stimulation of nicotine cholinergic receptors and its neuroteratogenicity<sup>7</sup>.

Carbon monoxide is a colourless, odourless gas produced from incomplete combustion of fossil fuels. Exhaust fumes from the vehicles, malfunctioning heaters, poorly ventilated fires and exposure to tobacco smoke are some of the commonest sources of carbon monoxide production. It enters the body mainly by inhalation. Haemmetabolism contributes to some of its endogenous production<sup>8</sup>. Carbon monoxide dissolves in the plasma and binds with haemoglobin, the oxygen transporting pigment. It has high affinity for haemoglobin about 240 times that of oxygen, shifting oxygen dissociation curve to left<sup>9</sup>. This results in unavailability and utilization of oxygen by the tissues. In foetus the affinity is still more about 172 times. This accounts for at least some of its toxic effects<sup>10,11</sup>. There is a close relationship between concentration of carbon monoxide in the expired air and maternal blood carboxyhaemoglobin (% COHb) concentration<sup>12</sup>.

The carbon monoxide is eliminated in exhaled breath due to dissociation of carboxyhaemoglobin allowing free carbon monoxide to be present in the expired air. This can be employed in estimating carbon monoxide levels in the blood by indirectly measuring

exhaled CO<sup>13</sup>. Also there is a direct link between the level of CO in an expectant mother's breath and the level of CO in her unborn foetus blood. This is known as "Fetal carboxyhaemoglobin" (%FCOHb)<sup>14</sup>. Proportion of **FCOHb** level is higher when compared to maternal COHb. This level has been found to be on average 1.8 times higher in the baby than in the mother<sup>15</sup>

Various methods are used to assess smoking exposure such as assays of cotinine (the major metabolite of nicotine) in urine and blood, hair nicotine, breath carbon monoxide analysis and self reporting. Measure of expired air carbon monoxide levels is a rapid, non-invasive and cheap method to assess exposure to passive smoking and can be used safely for antenatal clinic settings<sup>16</sup>. Breath CO monitors measure carbon monoxide in parts per million (ppm) in expired air and display breath concentration of CO reading along with its corresponding blood concentration levels.

Therefore, the present study is aimed at measurement of expired air carbon monoxide level (ppm) in passive pregnant smokers and corresponding % carboxy haemoglobin level (blood CO) using the non invasive Carbon monoxide check+ instrument.

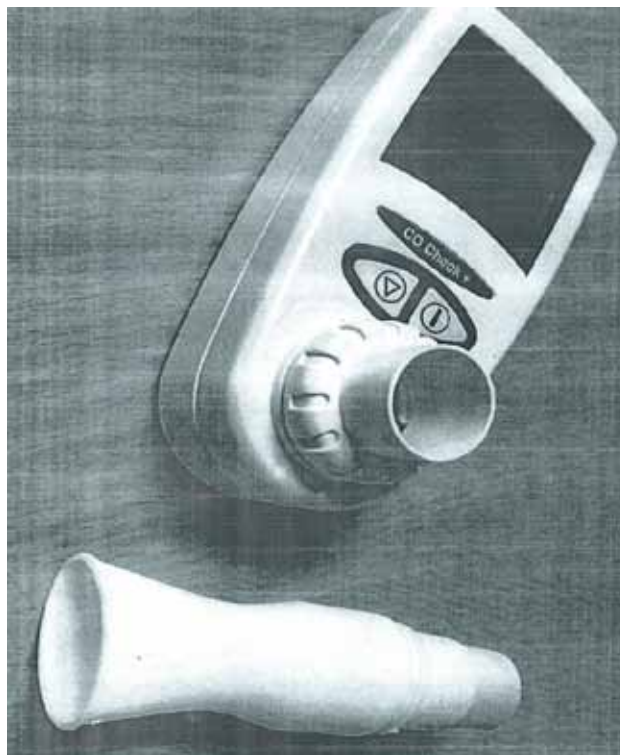
## Materials and Method

### Study Design: Prospective case control study

This study conducted in August 2014 in Govt Egmore maternity hospital after institutional ethics clearance. 100 pregnant women in the gestational age group between 26-34 weeks were selected randomly from morning antenatal clinic and classified into 2 groups those exposed to passive smoking (Exposure to other people's tobacco smoke) and those not exposed to passive smoking. **Inclusion criteria** for study selection: Pregnant women with gestational age 26-34 weeks (exposed as well as non exposed to passive smoking) **Exclusion Criteria:** Pregnant women who are active smokers, those exposed to cooking wood fire, known chronic obstructive pulmonary disease, pulmonary tuberculosis, acute or Chronic lung diseases, and other maternal related or general illness. All the participants included were informed about the study and a written and informed consent were obtained from them. They were subjected to complete general and systemic examination. The study and control group were subjected to non invasive assessment of expired air CO levels using CO check + instrument. After comfortably seated in the chair for a while the subjects were asked to inhale

deeply, hold the breath for 15 sec and exhale slowly into the disposable mouth piece attached to the CO check + instrument. Breath carbon monoxide reading were noted and reported as parts per million (ppm) .The CO Check + instrument detect carbon monoxide gas by means of an electrochemical gas sensor. They incorporate a graphic LCD displayer that display the carbon monoxide concentration level in a numerical format and/or colored indicators that correspond to various concentration

ranges like green 0-6 ppm indicates no exposure, yellow 7-10ppm indicates mild -moderate exposure andred 10-20ppm indicates severe exposure. The % COHb along with the results of CO she passed on to her unborn baby were also displayed in % FCOHbor foetalcarboxyhaemoglobin. All measurements were backed up with an appropriate colour code to show the risk of exposure. The sensitivity of the instrument is as low as 1 ppm.



**Figure 1: Carbon monoxide check plus instrument**

**Statistical Analysis:** The results of the above tests were evaluated statistically using Statistical Package for the Social Sciences (SPSS) software version 21.

**Results**

The mean and standard deviation of the variable were determined for the two groups. Independent student t test was employed as the Test of significance at 95% confidence interval and P value < 0.05 was considered as significant.

**Table 1: Comparison of CO in ppm in exhaled air between exposed and non exposed**

Variable	Group	N	Mean	SD	P value
CO (ppm)	Exposed	50	2.78	1.01	0.145**
	Non exposed	50	2.48	0.97	

\*\* p -value >0.05 not statistically significant

**Table 2: Comparison of % COHb in ppm between exposed and non exposed**

Variable	Group	N	Mean	SD	P value
%CO Hb(ppm)	Exposed	50	0.45	0.17	0.1186**
	Non exposed	50	0.39	0.15	
** p -value >0.05 not statistically significant					

Table 1 shows comparison of carbonmonoxide in ppm in exhaled air between exposed and non exposed to passive smoking which shows that the mean CO ppm in exposed group was  $2.78 \pm 1.01$  and that of non exposed group was  $2.48 \pm 0.97$ . There was no statistically significant difference between the two groups ( $p$ -value>0.05)

Table 2 shows comparison of % COHb between exposed and non exposed to passive smoking which shows mean % COHb was  $0.45 \pm 0.17$  and that off non exposed group  $0.39 \pm 0.15$ . There is no statistically significant difference between the two groups( $p$ -value>0.05).

### Discussion

Pregnant mothers fall under high risk groups. They transmit many substances to the unborn foetus compromising the outcome of the baby. These people when inhale carbon monoxide emitted from cigarette smoke passively tend to transmit the same to unborn foetus. Foetalhaemoglobin binds with carbon monoxide so that oxygen is made unavailable to foetal tissue. Exhaled air CO correlates better with blood CO percentage. Though many gold standard method are available to measure carbon monoxide levels, a non invasive simple method is used to find out the exposure to passive smoking in this study. The result of this study showed that expired air breath carbon monoxide analysis by breath monitors is less reliable in detecting exposure to passive smoking in pregnant women. In both case and control groups expired air CO levels were less than 6ppm which indicates no exposure ( $2.78 \pm 1.01$  and  $2.48 \pm 0.97$  respectively) and corresponding maternal blood % COHb< 0.96 ( $0.45 \pm 0.17$  and  $0.39 \pm 0.15$  respectively) shows highly insignificant results. This unreliability of the test may be related to some of the physiological changes that occur during pregnancy.

The clearance of some drugs, chemicals is altered during pregnancy which results in short half- life of carbon monoxide. This narrow window for detection

could be the reason for the negative results in this study (Koren G et al)<sup>17</sup>. The plasma half life of carbon monoxide is found to be 5 hours in air. Cotinine test is considered as most accurate method of measuring environmental tobacco exposure with longer half life about 9 hrs in pregnant women (Benowitz NL et al)<sup>18</sup>

As per the study by Frederiksen LW, Martin JE et al<sup>19</sup> shows the longer interval between an overnight sleep and the test results in the morning could explain the negative results.

Also the relatively low levels of carbon monoxide in breath during passive smoking when compared to those of active smokers may be the reason of this unreliability. Studies by Ashford KB et al<sup>20</sup> showed that passive exposure to smoking results in far lower levels of carbon monoxide in the breath compared with active tobacco smoking.

Thus the findings of this study confirmed that there is no difference in breath carbon monoxide levels between the study and the compared group. And the levels of carbon monoxide in exhaled air as measured by breath monitors can be considered as an invalid tool. But still this method can be used for screening smoking exposure among pregnant population and educating them to avoid further exposure to smoking environment. However further evaluation regarding the method of measurement to reduce passive smoking exposure among pregnant women; more vigorous biomarker detection tests to quantify the smoking exposure are needed<sup>21</sup>

This study population not included occupational environmental tobacco smoke exposure and domestic wood fire exposure which are other common causes of smoke; it should extend to this group too. Sometimes just eliciting history of chronic exposure to passive smoking in pregnant women will alert the primary health care personnel to reinforce the required care.

Antenatal clinic settings represent an opportunity to motivate pregnant women for avoidance of further

smoking exposure whether passive or active. There are studies that confirm health education on the harmful effects of passive smoking was associated with a reduction of further exposure.

The limitations of this study include the use of electronic device rather than gold standard biomarkers.

### Conclusion

The result of this study concludes that analysis of expired air carbon monoxide levels by breath monitors not be useful as marker of exposure to passive smoking in pregnant women. Lesser half life of carbon monoxide, various physiological and metabolic changes associated with pregnancy, prolonged time interval between the test and exposure might have made this test inconclusive. But in many Indian scenarios the seriousness of passive exposure of smoking usually ignored among pregnant women, thus exposing unborn foetus to various serious consequences. So non invasive portable breath monitors can be used as a tool to educate pregnant women to aware of exposure to passive smoking at earliest to avoid complications in the foetus.

**Conflict of Interest:** No

**Source of Funding:** Self

**Ethical Clearance:** Taken from Institutional Ethics Committee, Madras Medical College.

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