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Breath Analysis to Detect Recent Exposure to Exhaled Carbon Monoxide And Nicotine Dependence In Mathura – A Cross-Sectional Study

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Abstract

Background: Carbon monoxide (CO) is one of the most common and widely distributed air pollutants**.** Carbon monoxide (CO) is a poisonous, colorless, odorless and tasteless gas. Carbon monoxide is harmful when breathed because it displaces oxygen in the blood and deprives the heart, brain and other vital organs of oxygen.

Aim: To detect recent exposure to exhaled carbon monoxide and nicotine dependence in Mathura city.

Methods: A cross-sectional study was carried out by using hand held breath analyser to measure end expiratory carbon monoxide concentrations in 373 subjects. Questionnaire data were collected to assess the effect of common sources of carbon monoxide exposure on breath carbon monoxide levels. Smokers were used as a carbon monoxide exposed group for comparison with non smokers. Fagerstrom test for nicotine dependence was used to assess the levels of nicotine dependence in smokers.

Results: The exhaled carbon monoxide level was normal in 161 non smokers and 15 smokers out of 287 non smokers and 80 smokers. The mean carbon monoxide concentration in smokers and non smokers was 2.26±0.807 and 1.55±0.697 (p= 0.001) respectively. Passive smokers and frequent use of motor vehicle were associated with slight higher carbon monoxide concentration (p= 0.001) in the non smoking group. The frequency and year of smoking was found as a significant risk indicator for nicotine dependence. Exhaled CO levels were significantly correlated with the nicotine dependence

(p= 0.001) indicating it as a marker for nicotine dependence.

Conclusion: The present study showed that exhaled carbon monoxide concentration was higher in smokers and non smoking groups of passive smokers and motor vehicle users. The exhaled CO levels, frequency and year of smoking indicated a marker for nicotine dependence in smokers.

Keywords: Carbon monoxide levels, Fagerstrom Test Nicotine Dependence, smokers, passive smokers.

Introduction

Tobacco use is the most common cause of non-communicable disease related morbidity and mortality worldwide despite being preventable .[1] In developing countries like India, the disease burden, health care costs as well as other fiscal losses resulting from premature deaths attributable to tobacco consumption are increasing rapidly. World Health Organization (WHO) estimates in 2004 projected 58.8 million deaths to occur globally, of which 5.4 million are attributed to tobacco use. As of 2002, 70% of the deaths are in developing countries. It is predicted that 1.5–1.9 billion people will be smokers in 2025. India is the second largest consumer of tobacco in the world. The prevalence of all types of tobacco use among men has been reported to be high in most parts of the country (generally exceeding 50%). Further, a national level survey on tobacco use in India has reported that 16.2% are current smokers and 20.5% are tobacco chewers. This survey also showed that bidi is the most popular form of tobacco smoking, followed by cigarette smoking; similarly, pan with tobacco is the major chewing form of tobacco.[2] Tobacco Control Policy India Project Report revealed about 275 million tobacco users in India. Tobacco use is responsible for nearly half of all cancers among males and one quarter of all cancers among females and also for cardiovascular and respiratory diseases. Unless and until urgent action is taken, by 2020, tobacco consumption could cause more than 1.5 million death in India annually.[3] The prevalence of smoking in India is 13.3%.Bidi is the most popular form of smoking tobacco used in India, especially in rural areas, and the cigarette is the second most popular form of smoking tobacco, mainly used in urban areas. Although the cigarette smoke has many harmful chemicals such as nicotine, cotinine, tar, hydrogen cyanide, tobacco specific nitrosamines, carbon monoxide (CO), and polycyclic aromatic hydrocarbons, nicotine is the one most often associated with dependence.[4]

Carbon monoxide is a colourless, odourless gas produced from incomplete combustion of fossil fuels. The affinity of carbon monoxide for haemoglobin is about 240 times that of oxygen and this accounts for at least some of its toxic effect. Common sources of carbon monoxide include vehicle exhaust fumes, malfunctioning heaters or poorly ventilated fires, and smoking.[5]

Carbon monoxide is aptly named the “forgotten killer” because the diagnosis often eludes medical staff until too late.[6] Smoking or use of tobacco may be considered a curse to a healthy society. People who are in the viscinity with smokers inhale the smoke emitted by the smokers and are considered to be “secondary smokers” or “passive smokers”. The passive smokers also suffer from diseases related to smoking similar to active smokers. The CO remains in the blood for about 24 hours after inhalation of tobacco smoke depending on various factors such as gender, physical activity, and ventilation rate. It then reenters the alveoli because of concentration gradient at the alveoli. This CO that is present in expired air can be measured using portable CO analyser. The breath CO concentration has been found to be a reliable indicator of COHb level in the blood.[7] Nicotine dependence is characterised by tolerance,cravings, feeling a need to use

tobacco, withdrawal symptoms during periods of abstinence, and loss of control over the amount or duration of use.[8] Fagerstrom Test for Nicotine Dependence (FTND) is widely used to assess the nicotine dependence among the smokers.[4]

There is need to examine whether the exhaled CO levels indicate the nicotine dependence among smokers. There have been no studies conducted in Mathura city to measure the breath CO concentration in smokers and compare it with the exhaled breath CO concentration in non smokers.

Materials and Methods

A cross-sectional study was carried out on 373 subjects conducted over a period of 4 weeks among subjects (aged 18 years and above) who were selected by simple random sampling from OPD (Out Patient Department) of K.D. Dental College, Mathura. An informed consent was obtained before start of the study. Ethical approval has been taken from K.D. Dental college and Hospital, Mathura. Subjects, who smoked cigarette or bidi within the last 24 hours and asthmatics were included in the study. Participants who did not indicate since how long they had smoked were excluded from the study.

Sample size determination

Sample size was determined by the following formula based on the study population (n)

$$\frac{n = Z^2_{1-\alpha/2}\, p\,(1-p)}{d^2}$$

Anticipated population proportion (p)= 40% = 0.04

Confidence level= 95% $Z_{1-\alpha/2} = 1.96$

Permissible error (d) = 5% = 0.05

Therefore, 373 participants were randomly selected and then divided in to two groups: Smokers and Non smokers

Breath CO was measured in subjects using portable breath CO analyser. Questionnaire data were collected to assess the effect of common sources of carbon monoxide exposure on breath carbon monoxide levels. Fagerstrom test for nicotine dependence was used to assess the level of nicotine dependence. Smokers were used as a carbon monoxide exposed group for comparison with the non-smokers.

Procedure

The portable CO analyzer (piCO™) was used to measure the exhaled CO levels among the subjects. The subjects were asked to inhale deeply, hold the breath for 15 seconds and then exhale fully into the mouthpiece of instrument. If the subjects were unable to hold breath for that long, they were asked to hold breath for as long as possible. Single measurement was taken in each case; repeat measurements were done only when the subjects failed to do it properly.

Statistical analysis

The data obtained were tabulated and analysed using statistical package for social sciences, version 23.0 (SPSS). Mean carbon monoxide concentrations were compared using the independent t test. Spearman's rank correlation test was used to correlate between the nicotine dependence, sociodemographic and smoking characteristics. p value of ≤ 0.05 was considered to be statistically significant.

Results

The present study was conducted to detect recent exposure to exhaled carbon monoxide and nicotine dependence. Out of 373 subjects, 6 subjects were excluded from the study in which 2 subjects for whom there was no record of how long they had smoked and 4 subjects who smoked both cigarette and bidi.

Variables of the study population such as age, gender, passive smokers, motor vehicle, fossil fuel showed statistically significant results among both smokers and non smokers **Table 1**. Among total study population (n=80), result showed that exhaled carbon monoxide level

was high (11-30 ppm) in 52.5% smokers **Table 2 (A)**. Among total study population (n=287), result showed that exhaled carbon monoxide level was high (11-30 ppm) in 11.5% smokers in **Table 2 (B)**. The mean carbon monoxide concentration in smokers and non smokers showed statistically significant result (p= 0.001) in **Table 3.** The mean carbon monoxide concentration among smokers smoking 1-10 cigarettes per day and 11-20 cigarettes per day showed statistically significant result (p=0.001) in **Table 4**. All independent variables such as age, gender, marital status, motor vehicle use, fossil fuel use, pattern of use, frequency of consumption and year of smoking respectively showed the statistically significant (p=0.005) relation with the dependent variable that is exhaled carbon monoxide level except passive smokers (p=0.298) in **Table 5** .All independent variables such as age, gender, passive smokers, motor vehicle use, fossil fuel use, pattern of use, frequency of consumption and year of smoking respectively showed the statistically significant (p=0.001) relation with the dependent variable that is nicotine dependence except marital status (p= 0.088) in **Table 6**.

Table 1: characteristics of study population

Characteristic	Classification	Smokers (N=80)	Non-Smokers (N=287)	Mean Difference	P Value
Age	18-30 years	16 (20%)	111 (38.7%)	0.427	0.001**
	31-45 years	26 (32.5%)	91 (31.7%)		
	46-60 years	25 (31.2%)	56 (19.5%)		
	61-75 years	13 (16.2%)	29 (10.1%)		
Gender	Male	67 (83.8%)	141 (49.1%)	0.346	0.001**
	Female	13 (16.2%)	146 (50.9%)		
Marital status	Married	72 (90%)	268 (93.4%)	0.034	0.307
	Unmarried	8 (10%)	19 (6.6%)		
Passive smokers	Yes	44 (55%)	97 (33.8%)	0.212	0.001**
	No	36 (45%)	190 (66.2%)		
Motor vehicle	Use	58 (72.5%)	100 (34.8%)	0.377	0.001**
	Not use	22 (27.5%)	187 (65.2%)		
Fossil fuel	Use	39 (48.8%)	76 (26.5%)	0.223	0.001**
	Not use	41 (51.2%)	211 (73.5%)		

Test used = Independent t test **** statistically significant value (p≤0.05)**

Table 2 (A): Exhaled carbon monoxide levels among the smokers (n=80)

Exhaled Carbon Monoxide Level	Smokers (%)
Normal (0-6 ppm)	15 (18.7)
Medium (7-10 ppm)	23 (28.7)
High (11-30 ppm)	42 (52.5)

Table 2(b): exhaled carbon monoxide levels among the non-smokers (n=287)

Exhaled Carbon Monoxide Level	Non-Smokers (%)
Normal (0-6 ppm)	161(56.1)
Medium (7-10 ppm)	93 (32.4)
High (11-30 ppm)	33 (11.5)

Table 3: mean carbonmonoxide concentration in smokers and non smokers

	Smokers Mean	Non-Smokers Mean	P-Value	Mean Difference	Confidence Interval	
					Lower	Upper
Carbon monoxide concentration	2.26±0.807	1.55±0.697	0.001**	0.712	0.532	0.892

Test used = Independent t test **** statistically significant value (p≤0.05)**

Table 4: mean carbon monoxide concentrations in smokers according to frequency of smoking

Frequency of smoking	Carbon monoxide concentration			
	Mean	P value	Confidence interval	
			Lower	Upper
1-10 cigarettes per day	2.00±0.840	0.001**	-1.089	-0.411
11-20 cigarettes per day	2.75±0.441	0.001**	-1.035	-0.465

Test used = Independent t test **** statistically significant value (p≤0.05)**

Table 5: correlation between the exhaled carbon monoxide level, sociodemographic and smoking characteristics of the study subjects

Dependent Variable	Independent Variables	Correlation Coefficient ®	P Value
Exhaled carbon monoxide level	Age	0.531	0.001**
	Gender	0.280	0.001**
	Marital status	0.294	0.001**
	Passive smoker	0.054	0.298
	Motor vehicle use	0.128	0.014**
	Fossil fuel use	0.490	0.001**
	Pattern of use	0.380	0.001**
	Frequency of consumption	0.398	0.001**
	Years of smoking	0.394	0.001**

Test used = spearman's rank correlation

**** statistically significant value (p≤0.05)**

Table 6: correlation between the nicotine dependence, sociodemographic and smoking characteristics of the study subjects

Dependent Variable	Independent Variables	Correlation Coefficient ®	P Value
Nicotine dependence (FTND)	Age	0.222	0.001**
	Gender	0.285	0.001**
	Marital status	0.089	0.088
	Passive smoker	0.187	0.001**
	Motor vehicle use	0.300	0.001**
	Fossil fuel use	0.197	0.001**
	Pattern of use	0.996	0.001**
	Frequency of consumption	0.973	0.001**
	Years of smoking	0.996	0.001**
	Exhaled carbon monoxide level	0.389	0.001**

Test used = spearman'srank correlation

**** Statistically significant value (p≤0.05)**

Discussion

India's tobacco problem is very complex, with a large use of a variety of smoking forms and an array of smokeless tobacco products.[9] Tobacco use is a complex multistage behaviour influenced by the genes and the environment. The active content of tobacco 'Nicotine' leads to physical and psychological dependence.[10] Environmental tobacco smoke were 1.6 to 2.0 times higher than those found in other types of workplace and 1.5 times higher than those in homes with at least one smoker. Passive smoking has been found to increase the risk of developing lung cancer and ischemic heart disease.[11]

In present study age, gender, passive smokers, motor vehicle, use of fossil fuel showed a statistically significant difference among the smokers and non smokers. The results of the present study were in agreement with a study conducted by A J Cunnington, P Hormbrey (2002)[5] which showed a statistically significant difference among smokers and non smokers except the gender. In present study, marital status showed no statistically significant difference among smokers and non smokers. On a contrary, study conducted by K. J. Divinakumar et al (2017)[11] showed a statistically significant difference among smokers and non smokers. Exhaled carbon monoxide level was high in smokers and normal in non smokers in the present study. Previous study conducted by Sugavanesh P et al (2018)[4] and A J Cunnington et al (2002)[5] and Jane Hung et al (2006)[12] also found similar results. In the present study the mean carbon monoxide concentration in smokers and non smokers was 2.26±0.807 and 1.55±0.697 respectively and difference was found to be statistically significant. The result of the present study was in agreement with a study conducted by A J Cunnington et al (2002)[5] and Raj kumar et al (2010)[13] which also showed that mean carbon monoxide concentration among smokers and non smokers was statistically significant. In the present study the mean carbon monoxide concentration among smokers smoking1-10 cigarettes per day and 11-20 cigarettes per day was 2.00±0.840 and 2.75±0.441 respectively and difference found was statistically significant. In previous study conducted by Raj kumar et al (2010)[13], similar results were found. In present study, independent variables such as age, gender, passive smokers, motor

vehicle use, fossil fuel use, pattern of use, frequency of consumption and year of smoking respectively showed the statistically significant difference in relation with the dependent variable that is nicotine dependence except the marital status. In the previous study conducted by Sugavanesh P et al (2018)[4], similar results were found. In present study, marital status showed no statistically significant difference with the dependent variable that is nicotine dependence. On a contrary, in previous study conducted by K.J. Divinakumar et al (2017)[11], marital status found a statistically significant difference with the dependent variable that is nicotine dependence.

The exhaled CO levels were measured using the Pico smokerlyzer, with levels calibrated as 0-6 ppm, 7-10 ppm, 11-30 ppm. Hence, we were not able to calculate the exact cut-off level of CO for correcting with the nicotine dependence. The results of the study can be shared with the policymakers, nongovernmental organizations, and voluntary organizations to initiate appropriate interventions accordingly at the micro, meso, and the macro level.

Conclusion

Present study proved that smokers had very much higher breath carbon monoxide levels than non- smokers. The mean breath carbon monoxide increased in direct proportion to the carbon monoxide exposure (number of cigarettes smoked) in the smoking group. The exhaled CO levels, frequency and year of smoking indicated a marker for nicotine dependence in smokers.

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