The Relationship between Exhaled Carbon Monoxide Test and Peak Expiratory Flow Rate in Smokers and Non-smokers

N. N. Soeroso[1*], T. K. Intan[2], M. Ichwan[3], S. P. Tarigan[1] and A. S. Wahyuni[4]
[1]*Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara, Universitas Sumatera Utara Hospital, Jl. Dr. Mansyur No. 66 Medan 20154, Sumatera Utara, Indonesia*
[2]*Department of Anatomy Pathology, Faculty of Medicine, Universitas Sumatera Utara, Jl. Dr. Mansyur No. 5 Medan 20155, Sumatera Utara, Indonesia*
[3]*Department of Pharmacology, Faculty of Medicine, Universitas Sumatera Utara, Jl. Dr. Mansyur No. 5 Medan 20155, Sumatera Utara, Indonesia*
[4]*Department of Community Medicine, Faculty of Medicine, Universitas Sumatera Utara, Jl. Dr. Mansyur No. 5 Medan 20155, Sumatera Utara, Indonesia*

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Abstract: Cigarettes are one of the health problems in the community with an estimated 5 million people die every year. CO concentration in expiratory air is a reliable indicator of blood COHb levels. Aim of this study is to investigate the relationship between exhaled carbon monoxide test and PEFR in smokers and non-smokers. Design of this study was a cross-sectional. Fourty one subjects who were recruited by a consecutive sampling technique. The measurement of nicotine dependence rate was conducted by using Fagerstrom Tolerance Questionnaire (mFTQ). The expiratory CO levels were examined using piCO Smokerlyzer. Statistical analysis was done with logistic regression test and Spearman's correlation test by using software EpiInfo 7.0. Patients who had a risk of decreasing PEFR was found in men, aged >30 years, worked as an employee or entrepreneur, smokers, and had an expiratory CO level >5 ppm (p<0.05). It is also found that the higher CO levels in the body, the lower the percentage of an individual's PEFR; however, this correlation was not statistically significant. Furthermore, there was a significant relationship between sex, age, occupation, smoking status, and CO levels with PEFR values.

1 INTRODUCTION

Cigarettes are one of the causes of public health problems with an estimated mortality of 5 million people every year (WHO, 2006). More than 3000 journals and research published since the 1970s have shown the dangers of smoking to human health. Ironically, since 1998 to date, Indonesia still occupies the fifth rank for the most cigarette consumption and the third largest number of smokers in the world. The number of smokers in Indonesia continues to increase in line with an increasing population (Achadi, Soerojo & Barber, 2005).

WHO reported that 15 billion cigarettes are consumed every year. A WHO report in 2011 mentioned that China was listed as a country with the most cigarette consumption in the world (WHO, 2011). On the other hand, data in Indonesia showed that 67% of men were smokers, and 57% of them were daily smokers. The highest percentage of female smokers in the world was recorded in Nauru (50%) and Austria (48%) (WHO, 2015).

The most widely known components of cigarette smoke are tar, nicotine, carbon monoxide (CO), and other substances (Hoffman, 2001). When cigarette smoke passes through the airways, 4000 chemical substances including carbon monoxide will be absorbed through the lungs, will enter the bloodstream, and will bind to hemoglobin to form carboxyhemoglobin (COHb) in which its levels in the blood can be measured as an absorption marker of cigarette smoke (Kumar, 2010; Kendrick, 2010). CO concentration in expiratory air is a reliable indicator of blood CoHb levels (Jarvis, 1986). The purpose of this study was to investigate the relationship between expiratory air CO and APE in healthy smokers and non-smokers.

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2 METHODS

Subjects of this research were 41 subjects consisting of smokers and non-smokers and aged >20 years. The smoking status was documented through interviews. An individual is categorized as an active smoker if he has a smoking history of ≥100 cigarettes throughout his life (Ryan, 2012). Merc Phillips Respironics was used to examine the Peak Expiratory Flow Rate (PEFR). The interpretation used Pneumobile Project table. piCO Smokerlyzer was used to examine exhaled carbonmonoxide test and the interpretation used smokerlyzer® chart.

Data analysis of the relationship between CO levels and PEFR in healthy smokers and non-smokers used the Spearman's correlation test. On the other hand, factors influencing PEFR was analyzed with a logistic regression test. Data were analyzed using Epi Info software. This study used an informed consent and was approved by the Health Ethics Commission.

3 RESULTS

As shown in Table 1, the results showed that men were most often found in the study with approximately 63.4%, aged ≤30 years was around 46.3%, and smokers was around 51.2%. The PEFR examination results with the value of 251-500 was about 51.2%. Table 2 shows the correlation between CO levels and PEFR in which the higher CO levels in the body, the lower the percentage of an individual's PEFR although this result was not statistically significant. Table 4 shows a significant relationship between sex, age, occupation, smoking status, and CO levels with PEFR values. Patients who had a risk of decreasing PEFR were male, aged above 30 years old, worked as an employee or an entrepreneur, smoker, and CO level was more than 5.

Table 1: Characteristics of subjects

Variable		n	%
Sex	Male	26	63.4
	Female	15	36.6
Age	≤30 years	19	46.3
	31-40	13	31.7
	41-50	2	4.9
	51-60	2	4.9
	>60	5	12.2
Occupation	Student	19	46.3
	Employee	5	12.2
	Entrepreneur	17	41.5
Smoking status	Smoker	21	51.2
	Non-smoker	20	48.8
CO level (ppm)	0-5	23	56.1
	6-10	10	24.4
	11-20	3	7.3
	>20	5	12.2
PEFR percentage	0-29.9 %	0	0.0
	30-59.9%	5	12.2
	60-79.9 %	13	31.7
	≥80%	23	56.1
PEFR values	0-250	7	17.1
	251-500	21	51.2
	>500	13	31.7
Total		41	100.0

Table 2: Correlation between CO and PEFR

	Mean	SD	Median	Min-Max
CO level	8.34	8.7	5	2-35
PEFR percentage	76.2	15.8	80	34.5-120
PEFR values	403.7	127.2	370	180-600

Table 3: PEFR Percentage

	PEFR Percentage	
	p-value	r
Kadar CO	0.106	-0.26

Spearman's Correlation test

4 DISCUSSION

According to Riskesdas in 2010, the highest percentage of smokers was found in the age group of 45-54 years with 38.2%, followed by the age group of 25-34 years (Riskesdas, 2010). In this study, the dominant age was <30 years with 46.3%. The findings of this study indicate a significant relationship between sex, age, occupation, smoking status, and CO levels with PEFR values. Based on the existing literature, age can affect the absorption process and CO elimination through the diffusion path barrier in the lungs. Thus, the addition of age will make the air barrier in the lungs become.

The recommendation of the European Respiratory Society (ERS) consensus stated that expiratory CO levels in non-smokers were <4 ppm (Tonnesen, 2007). The results of the present study were also in accordance with the study of (Middleton, 2000) which determined CO ≤6 ppm as the limit for non-smokers

Table 4: Factors influencing PEFR

		Normal PEFR (≥80%)		Low PEFR (<80%)		*p-value*	OR	95%CI
		n	%	n	%			
Sex	Male	11	47.8	15	83.3	0.02	1	1
	Female	12	52.2	3	16.7		0.18	0.04 - 0.80
Age	≤30 years	14	60.9	5	27.8	0.03	1	1
	31-40	7	30.4	6	33.3		2.4	0.53 - 10.6
	41-60	2	8.7	2	11.1		2.8	0.3 - 25.5
	>60	0	0.0	5	27.8		NA	NA
Occupation	Student	15	65.2	4	22.2	0.01	1	1
	Employee	3	13.0	2	11.1		2.5	0.3 - 20.4
	Entrepreneur	5	21.7	12	66.7		8.9	1.9 - 41.0
Smoking status	Non-smoker	15	65.2	5	27.8	0.01	1	1
	Smoker	8	34.8	13	72.2		4.8	1.27 - 18.6
CO level	0-5	17	73.9	6	33.3	0.01	1	1
	6-10	2	8.7	8	44.4		11.3	1.8 - 69.07
	>20	4	17.4	4	22.2		2.83	0.53-15.04

(Middleton, 2000). The literature stated that the daily number of cigarettes consumed can affect the expiratory CO levels in smokers with estimated CO levels of 15-34 ppm if smoking 20 cigarettes/day which will increase to 25-60 ppm if smoking 40 cigarettes/day (Kendrick, 2010).

5 CONCLUSIONS

The study found that the higher the CO levels in the body, the lower the percentage of a person's PEFR; however, it was not statistically significant. The expiratory air CO levels in smokers were higher than non-smokers. Patients who had a risk of decreasing PEFR were found in male smokers aged above 30 years old who had expiratory CO levels greater than 5 ppm. However, the study had a limitation, namely the lack of sample size.

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