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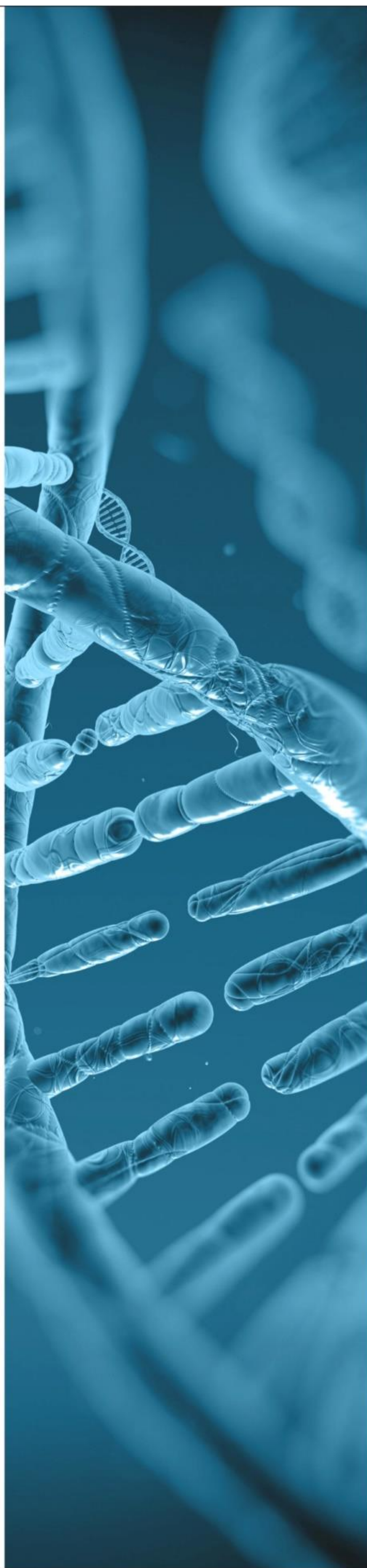

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Petunjuk Penulisan

Format penyusunan manuskrip
Manuskrip diketik pada kertas berukuran A4 (210 x 297 mm) dengan batas tepi 254 mm (*margin Normal)*, huruf diketik dengan tipe huruf (*font) Times New Roman*, besar huruf (*font size*) 12 point dengan menggunakan spasi rangkap 2 (*double space*). Setiap bagian dari manuskrip dimulai pada halaman baru dengan urutan sebagai berikut: halaman judul, abstrak dan kata kunci (*keywords*), teks keseluruhan, ucapan terima kasih, daftar pustaka, tabel dan gambar (setiap tabel dan gambar pada halaman terpisah). Nomor halaman dicantumkan secara berurutan dimulai dari halaman judul pada sudut sebelah kanan bawah. Manuskrip sebaiknya ditulis maksimal 16 halaman.

Halaman judul
Halaman judul mencakup: a) judul manuskrip yang dibuat sesingkat mungkin, spesifik informatif dan ringkasan judul tidak lebih dari 40 karakter (hitung huruf dan spasi) yang dicantumkan dibawah judul, b) nama penulis disusun berurutan dengan nama mahasiswa sebagai pengarang pertama, diikuti oleh Pembimbing sebagai pengarang kedua. Nama penulis ditulis lengkap tanpa gelar dan dicantumkan seperti aslinya, tidak dibalik seperti pada daftar pustaka dan sitasi, c) alamat setiap penulis, nama departemen dan lembaga afiliasi penulis, d) nama dan alamat penulis untuk korespondensi serta nomor telepon, nomor faksimili, alamat email. Judul penelitian dibuat jelas, singkat, spesifik, informatif, dan sesuai dengan topik manuskrip. Jumlah kata tidak lebih dari 12 kata agar mudah dan cepat dipahami pembaca.

Abstrak dan kata kunci
Abstrak berjumlah 200-250 kata ditulis dalam bahasa Indonesia dan Inggris. Abstrak berisikan latar belakang termasuk tujuan penelitian, metode, hasil, dan kesimpulan. Kata kunci dicantumkan di bawah abstrak pada halaman yang sama sebanyak 4-6 kata. Bagian abstrak merupakan ringkasan dari isi makalah yang dibuat secara singkat, informatif, dengan menekankan pada aspek baru dan penting dari penelitian.

Teks
Teks makalah manuskrip dibagi dalam beberapa bagian dengan judul sebagai berikut: ***Pendahuluan, Metode, Hasil, Pembahasan, Kesimpulan dan saran.***

Pendahuluan
a. Latar belakang merupakan bagian yang menjelaskan alasan mengapa masalah ini penting untuk diteliti. Bagian ini memuat penjelasan mengapa masalah itu dipandang menarik, penting, dan perlu diteliti untuk mencari pemecahannya. Penjelasan dapat diperoleh dari penelusuran pustaka yang berkaitan erat dengan masalah yang diteliti.
b. Keaslian penelitian dikemukakan dengan menunjukkan bahwa masalah yang dihadapi belum pernah dipecahkan oleh peneliti terdahulu atau dinyatakan dengan tegas perbedaan penelitian ini dengan penelitian terdahulu.
c. Tujuan penelitian yang menjelaskan hasil yang akan dicapai.

Metode
Metode penelitian berisi uraian terpadu dan sistematis mengenai bagaimana penelitian akan dilaksanakan. Metode terdiri dari :
a. Desain
b. Populasi / sampel (subjek) penelitian
Diuraikan kriteria inklusi dan eksklusi subjek penelitian, cara pemilihan sampel (subjek penelitian) secara random atau non-random, serta besar sampel yang akan di pilih. Teknik pemilihan sampel harus dijelaskan secara rinci. Bila perlu dibuat alur pemilihan sampel.
c. Bahan dan alat serta pengukuran
Bahan dan alat yang harus disajikan pada laporan terbatas pada bahan (materi) dan alat utama yang diperlukan untuk penelitian dan harus disebutkan spesifikasinya. Prosedur pengukuran perlu dijelaskan sesuai dengan tahapan yang dilakukan.
d. Alur kerja penelitian
Jalannya penelitian perlu dijelaskan mengenai jenis pendekatan yang dipakai untuk
mendapatkan data, melalui pendekatan laboratorium, klinik, komunitas, observasi, dll.
e. Analisis data
Perlu dijelaskan jenis teknik statistik yang digunakan untuk menjawab masalah dan mencapat tujuan penelitian. Data yang diperoleh dapat dianalisis menggunakan teknik statistik secara parametrik dan non-parametrik.

Hasil
Suatu hasil penelitian hendaknya disajikan dengan jelas, logis, runut, sehingga mudah untuk dimengerti. Hasil penelitian sebaiknya ditampilkan selain dalam bentuk narasi dapat pula berupa gambar, tabel, foto, dan grafik sehingga memudahkan untuk dipahami. Hasil dan interpretasi analisis statistik dituliskan secara jelas dalam uraian hasil penelitian.
Pada tahap awal disajikan distribusi karakteristik subjek penelitian, yang biasanya dibuat pada sebuah tabel. Kemudian disajikan temuan penting yang diperoleh, kalau cukup banyak sebaiknya pada sebuah tabel. Bila terbatas misalkan hanya satu atau dua temuan cukup dalam bentuk narasi/teks.
Tabel, bagan/gambar, grafik dibuat dengan jelas, diberi nomor urut serta keterangan yang jelas. Keterangan

tabel diletakan di atas tabel dan keterangan gambar diletakkan di bawah gambar. Maksimal tabel dan gambar 5. Semua tabel, grafik dan gambar diberi nomor dan keterangan yang jelas. Setiap tabel dianalisis dan diinterpretasi secara sistematik, dan hasilnya ditulis di bawah tabel tersebut. Perhitungan statistik detail tidak perlu ditulis dalam bagian hasil ini. Bila perhitungan statistik dianggap perlu ditulis, maka sebaiknya diletakkan dalam lampiran saja.

Pembahasan

Langkah awal harus diuraikan temuan penting yang diperoleh dari penelitian sesuai dengan tujuan penelitian. Kemudian bandingkan hasil penelitian yang diperoleh dengan hasil-hasil penelitian sebelumnya. Perlu dijelaskan kesesuaian dan ketidaksesuaian hasil penelitian yang didapat terhadap kerangka teori atau hasil penelitian lain yang telah dilakukan sebelumnya. Selanjutnya menggunakan teori-teori yang ada uraikan mekanisme terjadinya hasil penelitian tersebut. Bagian pembahasan juga menjelaskan mengenai kelemahan dan kelebihan penelitian yang telah dilakukan. Uraikan implikasi dari hasil penelitian yang diperoleh.

Kesimpulan

Kesimpulan hendaknya dibuat dalam bentuk narasi dan menguraikan secara singkat, jelas, padat menurut urutan yang sistematis. Bagian ini memuat tentang hasil penelitian yang telah diperoleh untuk menjawab tujuan penelitian. Saran menguraikan perlunya dilakukan penelitian lebih lanjut untuk memperbaiki kelemahan/ keterbatasan dari penelitian yang telah dilakukan.

Ucapan terima kasih

Ditujukan kepada pihak-pihak yang memberikan bantuan dana dan dukungan antara lain dukungan dari bagian dan lembaga, para professional yang memberikan kontribusi dalam penyusunan makalah, dan untuk penguji I maupun penguji II. Pembimbing tidak perlu dicantumkan pada Ucapan Terima Kasih karena sudah dicantumkan sebagai penulis.

Daftar Referensi

Daftar referensi/rujukan hanya mencatumkan rujukan yang telah digunakan dan ditulis menurut sistem Vancouver.

Online Submission

Penulis dapat mengirim naskah manuskrip melalui *online submission* di *website* Jurnal Biomedika dan Kesehatan.

Langkah online submission:

1. Pastikan naskah yang akan diunggah sudah mengikuti semua petunjuk penulisan
2. Lakukan pendaftaran author di : https://jbiomedkes.org/index.php/jbk/user/register
3. Setelah terdaftar silakan unggah naskah manuskrip dan isi form yang terdapat di dalam website, dan ikuti langkah selanjutnya.

Daftar Cek Pengiriman Naskah Manuskrip

□ Naskah manuskrip belum pernah dipublikasikan sebelumnya, juga tidak dalam pengajuan ke jurnal lain.

□ File manuskrip harus berformat OpenOffice, Ms. Word atau RTF dokumen, *font* 12, *Times New Roman, double spacing.*

□ Halaman judul harus memuat jelas judul, nama lengkap penulis tanpa gelar, departemen penulis, universitas, alamat lengkap, nomor telepon dan email.

□ Pelaporan data manuskrip dari penelitian yang melibatkan manusia dan hewan memerlukan persetujuan formal (kaji etik) oleh dewan peninjau atau komisi etik institusi yang bersangkutan.

□ Daftar rujukan memuat semua rujukan yang terdapat di dalam manuskrip dan ditulis sesuai urutan pengutipannya menggunakan sistem Vancouver.

Daftar Isi

Jurnal Biomedika dan Kesehatan - Vol. 5 No. 3 December 2022

Editorial

Original Article

Case Report

Review Article

JURNAL BIOMEDIKA DAN KESEHATAN
(JOURNAL OF BIOMEDIKA AND HEALTH)

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ORIGINAL ARTICLE

Pulmonary Function Test and its Correlation with Exhaled Carbon Monoxide and Smoking Habits in Ojek Drivers

Korelasi Karbon Monoksida dan Derajat Rokok dengan Fungsi Paru pada Pengemudi Ojek Online

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ABSTRACT

Background

Cigarette smoke is the main source of exposure to carbon monoxide (CO) besides air pollution. When cigarette smoke is inhaled, carbon monoxide is absorbed through the lungs, enters the bloodstream, and then binds to hemoglobin to form carboxyhemoglobin (COHb), whose levels in the blood can be measured as a marker of cigarette smoke absorption. Both smoking habits and CO levels can affect lung function, after smoking, blood CO levels will increase and lung function will decrease significantly.

Methods

This study used an analytic observational method with a cross-sectional design with a total sample of 99 respondents. Data collection in September-December 2022 using the Brinkman Index questionnaire, *Fagerstrom Test for Nicotine Dependence* (FTND) questionnaire, exhaled CO levels, and spirometry examination.

Results

47.5% exhaled CO levels on 0-6 ppm or in a green zone, 77.8% of subjects smoked, 57.6% FTND score was 0-2, 51.5% of subjects had restricted lung function, and 79.5% subjects with obstruction. Exhaled CO levels were strongly correlated with the Brinkman index ($r=0.654$, $p=0.000$), and moderately significant correlation with the FTND score ($r=0.544$, $p=0.000$). There is no correlation between exhaled CO levels and degree of smoking with lung function.

Conclusions

Exhaled CO levels have a significant correlation with smoking and nicotine dependence but do not correlate with pulmonary function test.

Keywords: Exhaled carbon monoxide level, smoking, pulmonary function test, nicotine dependence

ABSTRAK

Latar Belakang

Asap rokok merupakan sumber utama pajanan terhadap karbon monoksida (CO) selain polusi udara. Saat asap rokok terinhalasi, karbon monoksida akan diabsorpsi melalui paru, masuk ke dalam aliran darah kemudian akan berikatan dengan hemoglobin untuk membentuk karboksi – hemoglobin (COHb) yang kadarnya dalam darah dapat diukur sebagai marker absorpsi asap rokok. Baik rokok atau CO dapat mempengaruhi fungsi paru, setelah merokok maka kadar CO dalam darah akan meningkat dan fungsi paru akan menurun secara bermakna.

Metode

Penelitian ini menggunakan metode observasional analitik dengan desain potong lintang dengan besar sampel 99 responden. Pengambilan data pada bulan September-Desember 2022 dengan menggunakan kuesioner Indeks Brinkman, *Fagerstrom Test for Nicotine Dependence* (FTND), pengukuran CO ekspirasi dan pemeriksaan spirometri

Hasil

Sebanyak 47.5% responden memiliki kadar CO ekspirasi sebesar 0-6 ppm yang masih berada pada zona hijau, 77.8% responden merokok, 57.6% memiliki skor FTND 0-2, sebanyak 51.5% mengalami gangguan restriksi dan 79.5% responden mengalami gangguan obstruksi saluran napas. Kadar CO ekspirasi berkorelasi erat dengan indeks Brinkman (r=0.654, p=0.000), dan berkorelasi sedang bermakna dengan skor FTND (r=0.544, p=0.000). Tidak ada korelasi kadar CO ekspirasi, indeks Brinkman dan ketergantungan terhadap nikotin dengan fungsi paru.

Kesimpulan

kadar CO ekspirasi berkorelasi erat dengan rokok dan ketergantungan nikotin tetapi tidak berkorelasi dengan fungsi paru.

Kata Kunci: karbon monoksida ekspirasi, rokok, uji fungsi paru, ketergantungan nikotin

INTRODUCTION

The most common source of air pollution in urban areas comes from motorized vehicles. The development of traffic volume in urban areas has reached 15% every year in the last 10 years. Transportation in big cities is the largest source of air pollution, where 70% of air pollution in urban areas is caused by motorized vehicle activities, especially motorbikes, which reach 30%.[1] Parameters of air pollution from motorized vehicles such as carbon monoxide (CO), nitrogen oxides (NOx), methane (CH4), sulfur dioxide (SO2) and particulate matter can affect global warming.[1,2]

Apart from air pollution, cigarette smoke is also the main source of exposure to carbon monoxide (CO).3 Examination of exhaled air CO levels can be used as a biomarker for the degree of smoking. Smoking is a habit that is often found throughout the world, although it is generally known that cigarettes can cause health problems.[4] The percentage of smokers aged 15-19 years has increased in 2020, namely 10.61%, an increase from 10.54% in 2019 More than half (52.1%) of smokers in Indonesia smoked for the first time at the age of 15-19 years, according to Basic Health Research data.[5]

Cigarettes cause damage to almost all organs of the body, when cigarette smoke is inhaled, carbon monoxide will be absorbed through the lungs, enter the bloodstream, and then bind with hemoglobin to form carboxy-hemoglobin (COHb) whose levels in the blood can be measured as a marker for cigarette smoke absorption.[6] Carbon monoxide will remain in the blood for 24 hours after inhalation of cigarette smoke depending on several factors such as gender, physical activity, and respiratory rate.[7] In the blood, CO will then re-enter the alveoli because there is a concentration gradient in the alveoli, so the levels of CO contained in exhaled air can be measured using a portable CO meter.[8]

Endogenous carbon monoxide is produced primarily by systemic heme oxygenation and is eliminated through respiration. In healthy populations who do not smoke, end-tidal concentrations are in the range of 1-3 ppm.[9] Carbon monoxide is one of the most widely distributed pollutants in the air. CO concentrations are released into the air in the highest quantities among other air pollutants every year except for carbon dioxide (CO_2) concentrations.[3] In areas with high populations the ratio of mixed CO levels can reach up to 10 ppm. The most important biological characteristic of CO is its ability to bind to hemoglobin to form carboxyhemoglobin (HbCO) which is 200 times more stable than oxyhemoglobin (HbO_2) which can have fatal consequences because it can disrupt muscle metabolism and intracellular enzyme function due to the stable CO bond.[4,10]

Measurement of expiratory monoxide levels has been used to increase the validity of investigations of the degree of smoking because carbon monoxide measurements are easy to use, non-invasive, and affordable.[11] This method can provide a direct assessment of the degree of smoking and is a potential biomarker for assessing air pollution exposure.[3,4] Environmental exposures other than cigarette smoke are important factors that can differentiate exhaled CO results in passive smokers and non-smokers.[11,12]

Subjectively, a person's level of addiction to cigarettes is assessed using the Fagerstrom Test for Nicotine Dependence questionnaire, a questionnaire that was introduced in 1978. [13,14] This questionnaire contains a series of questions regarding how much a person cannot give up smoking. Objectively, the degree of smoking can be assessed by examining exhaled carbon monoxide levels between smokers and non-smokers and there is a strong correlation between exhaled carbon monoxide and the severity of smoking.[13,15]

Both cigarettes and CO can affect lung function. In research conducted by Yalcin et al., who conducted experimental research, after smoking, CO levels will increase and lung function will decrease significantly.[16] Ejazi et al.'s research also found that expiratory CO levels were significantly negatively correlated with the first-second forced expiratory volume (VEP1) in patients. chronic obstructive pulmonary disease (COPD).[17] Different research results were obtained by Salepci et al because there was no relationship between lung function and exhaled CO levels.[12] This study aims to assess the relationship between the degree of smoking and exhaled carbon monoxide levels with lung function in online motorcycle taxi drivers.[18]

METHODS

This research uses an analytical observational method with a cross-sectional design. Data was collected at the Faculty of Medicine Campus, Universitas Trisakti in September-December 2022. Respondents were selected using consecutive non-random sampling with the required sample size of 94 respondents and rounded up to 100 respondents.

The research population was online motorcycle taxi drivers who met the inclusion criteria (online motorcycle taxi drivers in DKI Jakarta and surrounding areas, male and female, aged 17 years – 60 years, negative antigen swab results, willing to be respondents, and able to carry out spirometry and expiratory CO procedures well). Respondents were excluded if they had a history of chronic lung disease and the spirometry examination was unacceptable or had no reproducibility). Respondents were then interviewed, filled out questionnaires, spirometry, and exhaled CO examinations.

Interview data includes identity and sociodemographic data, and filling out a questionnaire about smoking habits using the Brinkman index by calculating the number of cigarettes smoked per day and the number of years of smoking. The degree of nicotine dependence uses the Fagerstrom Test for Nicotine Dependence (FTND), with categories light (0-2), moderate (3-4), and severe (5-7). CO levels are checked using the piCO Smokerlyzer device, by holding the respondent's breath for 15 seconds, then exhaling it slowly until it runs out and the results will be visible on the measuring instrument. Light levels/green zone (0-6 ppm), medium/yellow zone (7-10 ppm) and heavy/red zone (≥11). Lung function examination used a Minato AS-507 spirometer, measuring vital capacity (CV) and first-second expiratory volume (VEP1) which was carried out three times, and the highest value was taken and compared with the predicted value. Lung function test results are then categorized as normal if CV and VEP1 are ~80%, mild restriction (CV 60-79.9%), moderate restriction (CV 30-59.8%), and severe restriction (CV <30%), while mild obstruction (VEP1 60%) -79.9%), moderate obstruction (VEP1 30-59.9%) and severe obstruction (VEP1 <30%). Statistical test analysis uses the Spearman correlation test using SPSS version 25. This research has passed ethical review by the ethics commission of the Faculty of Medicine, Universitas Trisakti, with number 166/KER/FK/VIII/2022.

RESULTS

Univariate analysis was used to determine the frequency distribution of subject characteristics in the form of gender, age, serum 25(OH)D levels, Schirmer test, TBUT, and OSDI scores.

Table 1. Data on subject characteristics (N=57)

Variable		Frequency (%)	Mean±SD
Gender			
Men	26	(41.3%)	
Women	31	(67.7%)	
Age (year)			
25 – 40	24	(42.1%)	42.0 ± 8.7
> 40	33	(57.9%)	
Serum level 25 (OH)D			
≥ 30ng/ml	11	(19.3%)	22.0 ± 11.64
< 30ng/ml	46	(80.7%)	
Schirmer test			
>10 mm	32	(56.1%)	13.13±8.91
≤10 mm	25	(43.9%)	
TBUT			
≥10 seconds	22	(38.6%)	9.08±4.56
<10 seconds	35	(61.4%)	
OSDI score			
0-12	34	(59.6%)	22±11.64
>13	23	(40.4%)	

Based on characteristic data obtained from 57 research subjects, 67.7% were dominated by women with an average age of 42.0 ± 8.7. Judging from the serum 25(OH)D levels, it was found that 80.7% had vitamin D deficiency. For the DES examination with the Schirmer test, 56.1% were normal, while for the TBUT examination, 61.4% showed disruption of the tear film and for OSDI the score was 59.6. % normal.

Table 2. Analysis of Respondent Characteristics using the Schirmer test and TBUT

	Schirmer test		p value	TBUT		p value
Variable	>10mm	≤10mm		>10 seconds	≤10 seconds	
Gender						
Men	5(19.2%)	21(80.8%)	0.174	7(26.9%)	19(73.1%)	0.860€
Women	11(35.5%)	0(64.5%)		9(29.0%)	22(71.0%)	
Age (year)						
25 – 40	18(69.2%)	8(30.8%)	0.783	10(41.7%)	14(58.3%)	0.044€
>40	12(38.7%)	19(61.3%)		12(36.4%)	21(63.6%)	
Serum level 25(OH)D						
≥30ng/ml	(27.3%)	8(72.7%)	0.948	6(54.5%)	5(45.5%)	0.030€
<30ng/ml	13(28.3%)	33(71.7%)			36(78.3%)	

€ = Chi-square test(p<0.05)

Based on Table 2 above, it can be concluded that there is no significant relationship between gender (p=0.174), age (p=0.783) vitamin D levels (p=0.948), and the Schirmer test. However, the TBUT examination showed a significant relationship with age (p=0.044) and vitamin D levels (p=0.030), whereas the relationship between gender and the TBUT examination was not found to be significant (p=0.860).

Table 3 Bivariate Analysis of Respondent Characteristics with OSDI scores

	OSDI Score		
Variable	0 – 12	> 13	p value€
Gender			
Men	15(57.7%)	11(42.3%)	0.783
Women	19(61.3%)	12(38.7%)	
Age (year)			
25 – 40	15(62.5%)	9(37.5%)	0.708
>40	19(57.6%)	14(42.4%)	
Serumn level 25(OH)D			
≥30ng/dl	5(45.5%)	6(54.5%)	0.285
<30ng/dl	29(63.0%)	17(37.0%)	

€ = Chi-square test (p<0.05)

Based on Table 3 above, it can be concluded that there is no significant relationship between gender (p=0.783), age (p=0.708), and vitamin D levels (p=0.285) with the OSDI questionnaire.

DISCUSSION

This study aimed to assess the correlation between CO levels and the degree of smoking and lung function in online motorcycle taxi drivers. The median CO level in this study was 7 ppm with the highest value being 36 ppm almost half of the respondents (47.5%) were in the green zone and the remaining 37.3% were in the red zone. Respondents who smoked in this study amounted to 75.7% with a median Brinkman index of 80 and a maximum value of 936. In this study, the average CO level was found to be 12.16 ppm in respondents who smoked, while in those who did not smoke it was 2.76 ppm. Smokers' exhaled CO levels in this study were higher than in similar studies, such as Maga et al (smokers 8.25 ppm vs non-smokers 3.26 pm), but lower than Warsaw et al (smokers 14.4 ppm vs non-smokers 5.1 ppm).[3] In many studies CO levels Expiration in smokers is significantly higher than in non-smokers, but the cut-off point between the two is not yet clear.[7,19] Research in Korea by Kim et al concluded that a cut-point value of 5 ppm has a sensitivity of 80-98.3% with a specificity of 100% in smoking cessation programs for stated that the respondent had stopped completely. If a smoker stops smoking for a long period, his exhaled CO levels can decrease to the same as those of a non-smoker.[19] Research by Cropsey et al even created a cut point of 3 ppm to differentiate smokers from non-smokers, which is considered accurate for all races and does not differentiate between genders. 20 Differences in exhaled CO levels, especially in smokers, can be influenced by many things, such as age, distribution of respondents who are heavy smokers, intensity of exposure to cigarette smoke, depth of inhalation, type of cigarette, last time smoked, or the influence of other factors such as air and environmental pollution.[19, 21] In addition to the cut point for smokers and nonsmokers, some researchers recommend a limit of 10 ppm as a threshold for dangerous CO levels.[19]

The pulmonary function test in this study uses CV and VEP1 parameters to assess whether there is restriction or obstruction. Of the respondents, the results showed that more than half (51.5%) of the respondents experienced restrictive disorders with mild restrictions at 42.4% and 78.8% of respondents experienced obstructive disorders. The results of the spirometry examination were normally distributed with the mean CV and VEP1 between smokers and non-smokers not significantly different, the CV values (79.35% vs 78% with p = 0.732) and VEP1 (55.31% VC 66.96% with p = 0.630). Similar research results were obtained by Saiphoklang et al who did not obtain a significant difference in VEP1 values between smokers and non-smokers (p=0.444).[21]

In the correlation test, it was found that CO levels were significantly positively correlated with the degree of smoking, whether assessed from the Brinkman index or the FTND questionnaire. Expired CO levels have been widely used to assess indicators of the severity of a person's smoking habit.[22] Many studies have been carried out to assess the relationship between exhaled CO levels and smoking habits, the severity of smoking is related to higher expiratory CO levels.[23]

Cigarettes contain thousands of chemicals that are dangerous to humans. Free radicals, nicotine, and CO are believed to have the most dangerous effects. Cigarettes increase CO levels in the blood which will cause various cardiovascular diseases because CO replaces oxygen in the blood to form carboxyhemoglobin /COHb bonds. Measurement of expiratory CO and CoHb levels is a non-invasive and objective measurement to assess the degree of smoking and has been widely used in various studies.[23]

The results of this study did not show a correlation between lung function and exhaled CO levels or the degree of smoking. In experimental tests, there was a significant difference in lung function (KVP and VEP1) before and after smoking shisha ($p<0.05$). Measurements of lung function and expiratory CO were carried out after the respondents were given treatment to smoke shisha, there was a significant increase in CO and a decrease in lung function before and after the intervention.[9] Soeroso et al, research also found a weak correlation between CO and peak expiratory flow, the higher the CO levels. Expiration will reduce peak expiratory flow (r=-0.26 and p=0.106). [23] Similar results to researchers obtained by Salepci et al, expiratory CO levels were also not found to have a significant correlation with force expiratory flow/ FEF 25-75% ((r =-0.05, p=0.527).[18] This lack of correlation could be caused by several factors including no data on how many cigarettes were smoked in the last 12 hours and how long the respondent had not smoked before the examination.

CONCLUSION

This research found that the heavier the degree of smoking and the higher the nicotine dependence, the higher the exhaled CO levels. There was no correlation between KVP and VEP1 with exhaled CO levels and degree of smoking.

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None

AUTHORS CONTRIBUTION

RK: Concept, research design, analysis, interpretation of results, and preparation of published articles; RK, MA, DAWS: Data collection, reviewed the article and approved publication.

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CONFLICT OF INTEREST

Competing interests: No relevant disclosures

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Pulmonary Function Test and its Correlation with Exhaled Carbon Monoxide and Smoking Habits in Ojek Drivers

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ORIGINAL ARTICLE

Pulmonary Function Test and its Correlation with Exhaled Carbon Monoxide and Smoking Habits in Ojek Drivers

Korelasi Karbon Monoksida dan Derajat Rokok dengan Fungsi Paru pada Pengemudi Ojek Online

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ABSTRACT

Background

Cigarette smoke is the main source of exposure to carbon monoxide (CO) besides air pollution. When cigarette smoke is inhaled, carbon monoxide is absorbed through the lungs, enters the bloodstream, and then binds to hemoglobin to form carboxyhemoglobin (COHb), whose levels in the blood can be measured as a marker of cigarette smoke absorption. Both smoking habits and CO levels can affect lung function, after smoking, blood CO levels will increase and lung function will decrease significantly.

Methods

This study used an analytic observational method with a cross-sectional design with a total sample of 99 respondents. Data collection in September-December 2022 using the Brinkman Index questionnaire, *Fagerstrom Test for Nicotine Dependence* (FTND) questionnaire, exhaled CO levels, and spirometry examination.

Results

47.5% exhaled CO levels on 0-6 ppm or in a green zone, 77.8% of subjects smoked, 57.6% FTND score was 0-2, 51.5% of subjects had restricted lung function, and 79.5% subjects with obstruction. Exhaled CO levels were strongly correlated with the Brinkman index ($r=0.654$, $p=0.000$), and moderately significant correlation with the FTND score ($r=0.544$, $p=0.000$). There is no correlation between exhaled CO levels and degree of smoking with lung function.

Conclusions

Exhaled CO levels have a significant correlation with smoking and nicotine dependence but do not correlate with pulmonary function test.

Keywords: Exhaled carbon monoxide level, smoking, pulmonary function test, nicotine dependence

ABSTRAK

Latar Belakang

Asap rokok merupakan sumber utama pajanan terhadap karbon monoksida (CO) selain polusi udara. Saat asap rokok terinhalasi, karbon monoksida akan diabsorpsi melalui paru, masuk ke dalam aliran darah kemudian akan berikatan dengan hemoglobin untuk membentuk karboksi – hemoglobin (COHb) yang kadarnya dalam darah dapat diukur sebagai marker absorpsi asap rokok. Baik rokok atau CO dapat mempengaruhi fungsi paru, setelah merokok maka kadar CO dalam darah akan meningkat dan fungsi paru akan menurun secara bermakna.

Metode

Penelitian ini menggunakan metode observasional analitik dengan desain potong lintang dengan besar sampel 99 responden. Pengambilan data pada bulan September-Desember 2022 dengan menggunakan kuesioner Indeks Brinkman, *Fagerstrom Test for Nicotine Dependence* (FTND), pengukuran CO ekspirasi dan pemeriksaan spirometri

Hasil

Sebanyak 47.5% responden memiliki kadar CO ekspirasi sebesar 0-6 ppm yang masih berada pada zona hijau, 77.8% responden merokok, 57.6% memiliki skor FTND 0-2, sebanyak 51.5% mengalami gangguan restriksi dan 79.5% responden mengalami gangguan obstruksi saluran napas. Kadar CO ekspirasi berkorelasi erat dengan indeks Brinkman ($r=0.654$, $p=0.000$), dan berkorelasi sedang bermakna dengan skor FTND ($r=0.544$, $p=0.000$). Tidak ada korelasi kadar CO ekspirasi, indeks Brinkman dan ketergantungan terhadap nikotin dengan fungsi paru.

Kesimpulan

kadar CO ekspirasi berkorelasi erat dengan rokok dan ketergantungan nikotin tetapi tidak berkorelasi dengan fungsi paru.

Kata Kunci: karbon monoksida ekspirasi, rokok, uji fungsi paru, ketergantungan nikotin

INTRODUCTION

The most common source of air pollution in urban areas comes from motorized vehicles. The development of traffic volume in urban areas has reached 15% every year in the last 10 years. Transportation in big cities is the largest source of air pollution, where 70% of air pollution in urban areas is caused by motorized vehicle activities, especially motorbikes, which reach 30%.[1] Parameters of air pollution from motorized vehicles such as carbon monoxide (CO), nitrogen oxides (NOx), methane (CH_4), sulfur dioxide (SO_2) and particulate matter can affect global warming.[1,2]

Apart from air pollution, cigarette smoke is also the main source of exposure to carbon monoxide (CO).3 Examination of exhaled air CO levels can be used as a biomarker for the degree of smoking. Smoking is a habit that is often found throughout the world, although it is generally known that cigarettes can cause health problems.[4] The percentage of smokers aged 15-19 years has increased in 2020, namely 10.61%, an increase from 10.54% in 2019 More than half (52.1%) of smokers in Indonesia smoked for the first time at the age of 15-19 years, according to Basic Health Research data.[5]

Cigarettes cause damage to almost all organs of the body, when cigarette smoke is inhaled, carbon monoxide will be absorbed through the lungs, enter the bloodstream, and then bind with hemoglobin to form carboxy-hemoglobin (COHb) whose levels in the blood can be measured as a marker for cigarette smoke absorption.[6] Carbon monoxide will remain in the blood for 24 hours after inhalation of cigarette smoke depending on several factors such as gender, physical activity, and respiratory rate.[7] In the blood, CO will then re-enter the alveoli because there is a concentration gradient in the alveoli, so the levels of CO contained in exhaled air can be measured using a portable CO meter.[8]

Endogenous carbon monoxide is produced primarily by systemic heme oxygenation and is eliminated through respiration. In healthy populations who do not smoke, end-tidal concentrations are in the range of 1-3 ppm.[9] Carbon monoxide is one of the most widely distributed pollutants in the air. CO concentrations are released into the air in the highest quantities among other air pollutants every year except for carbon dioxide (CO_2) concentrations.[3] In areas with high populations the ratio of mixed CO levels can reach up to 10 ppm. The most important biological characteristic of CO is its ability to bind to hemoglobin to form carboxyhemoglobin (HbCO) which is 200 times more stable than oxyhemoglobin (HbO_2) which can have fatal consequences because it can disrupt muscle metabolism and intracellular enzyme function due to the stable CO bond.[4,10]

Measurement of expiratory monoxide levels has been used to increase the validity of investigations of the degree of smoking because carbon monoxide measurements are easy to use, non-invasive, and affordable.[11] This method can provide a direct assessment of the degree of smoking and is a potential biomarker for assessing air pollution exposure.[3,4] Environmental exposures other than cigarette smoke are important factors that can differentiate exhaled CO results in passive smokers and non-smokers.[11,12]

Subjectively, a person's level of addiction to cigarettes is assessed using the Fagerstrom Test for Nicotine Dependence questionnaire, a questionnaire that was introduced in 1978. [13,14] This questionnaire contains a series of questions regarding how much a person cannot give up smoking. Objectively, the degree of smoking can be assessed by examining exhaled carbon monoxide levels between smokers and non-smokers and there is a strong correlation between exhaled carbon monoxide and the severity of smoking.[13,15]

Both cigarettes and CO can affect lung function. In research conducted by Yalcin et al., who conducted experimental research, after smoking, CO levels will increase and lung function will decrease significantly.[16] Ejazi et al.'s research also found that expiratory CO levels were significantly negatively correlated with the first-second forced expiratory volume (VEP1) in patients. chronic obstructive pulmonary disease (COPD).[17] Different research results were obtained by Salepci et al because there was no relationship between lung function and exhaled CO levels.[12] This study aims to assess the relationship between the degree of smoking and exhaled carbon monoxide levels with lung function in online motorcycle taxi drivers.[18]

METHODS

This research uses an analytical observational method with a cross-sectional design. Data was collected at the Faculty of Medicine Campus, Universitas Trisakti in September-December 2022. Respondents were selected using consecutive non-random sampling with the required sample size of 94 respondents and rounded up to 100 respondents.

The research population was online motorcycle taxi drivers who met the inclusion criteria (online motorcycle taxi drivers in DKI Jakarta and surrounding areas, male and female, aged 17 years – 60 years, negative antigen swab results, willing to be respondents, and able to carry out spirometry and expiratory CO procedures well). Respondents were excluded if they had a history of chronic lung disease and the spirometry examination was unacceptable or had no reproducibility). Respondents were then interviewed, filled out questionnaires, spirometry, and exhaled CO examinations.

Interview data includes identity and sociodemographic data, and filling out a questionnaire about smoking habits using the Brinkman index by calculating the number of cigarettes smoked per day and the number of years of smoking. The degree of nicotine dependence uses the Fagerstrom Test for Nicotine Dependence (FTND), with categories light (0-2), moderate (3-4), and severe (5-7). CO levels are checked using the piCO Smokerlyzer device, by holding the respondent's breath for 15 seconds, then exhaling it slowly until it runs out and the results will be visible on the measuring instrument. Light levels/green zone (0-6 ppm), medium/yellow zone (7-10 ppm) and heavy/red zone (≥11). Lung function examination used a Minato AS-507 spirometer, measuring vital capacity (CV) and first-second expiratory volume (VEP1) which was carried out three times, and the highest value was taken and compared with the predicted value. Lung function test results are then categorized as normal if CV and VEP1 are ~80%, mild restriction (CV 60-79.9%), moderate restriction (CV 30-59.8%), and severe restriction (CV <30%), while mild obstruction (VEP1 60%) -79.9%), moderate obstruction (VEP1 30-59.9%) and severe obstruction (VEP1 <30%). Statistical test analysis uses the Spearman correlation test using SPSS version 25. This research has passed ethical review by the ethics commission of the Faculty of Medicine, Universitas Trisakti, with number 166/KER/FK/VIII/2022.

RESULTS

Univariate analysis was used to determine the frequency distribution of subject characteristics in the form of gender, age, serum 25(OH)D levels, Schirmer test, TBUT, and OSDI scores.

Table 1. Data on subject characteristics (N=57)

Variable	Frequency	(%)	Mean±SD
Gender			
Men	26	(41.3%)	
Women	31	(67.7%)	
Age (year)			
25 – 40	24	(42.1%)	42.0 ± 8.7
> 40	33	(57.9%)	
Serum level 25 (OH)D			
≥ 30ng/ml	11	(19.3%)	22.0 ± 11.64
< 30ng/ml	46	(80.7%)	
Schirmer test			
>10 mm	32	(56.1%)	13.13±8.91
≤10 mm	25	(43.9%)	
TBUT			
≥10 seconds	22	(38.6%)	9.08±4.56
<10 seconds	35	(61.4%)	
OSDI score			
0-12	34	(59.6%)	22±11.64
>13	23	(40.4%)	

Based on characteristic data obtained from 57 research subjects, 67.7% were dominated by women with an average age of 42.0 ± 8.7. Judging from the serum 25(OH)D levels, it was found that 80.7% had vitamin D deficiency. For the DES examination with the Schirmer test, 56.1% were normal, while for the TBUT examination, 61.4% showed disruption of the tear film and for OSDI the score was 59.6. % normal.

Table 2. Analysis of Respondent Characteristics using the Schirmer test and TBUT

	Schirmer test		p value	TBUT		p value
Variable	>10mm	≤10mm		>10 seconds	≤10 seconds	
Gender						
Men	5(19.2%)	21(80.8%)	0.174	7(26.9%)	19(73.1%)	0.860€
Women	11(35.5%)	0(64.5%)		9(29.0%)	22(71.0%)	
Age (year)						
25 – 40	18(69.2%)	8(30.8%)	0.783	10(41.7%)	14(58.3%)	0.044€
>40	12(38.7%)	19(61.3%)		12(36.4%)	21(63.6%)	
Serum level 25(OH)D						
≥30ng/ml	(27.3%)	8(72.7%)	0.948	6(54.5%)	5(45.5%)	0.030€
<30ng/ml	13(28.3%)	33(71.7%)			36(78.3%)	

€ = Chi-square test(p<0.05)

Based on Table 2 above, it can be concluded that there is no significant relationship between gender (p=0.174), age (p=0.783) vitamin D levels (p=0.948), and the Schirmer test. However, the TBUT examination showed a significant relationship with age (p=0.044) and vitamin D levels (p=0.030), whereas the relationship between gender and the TBUT examination was not found to be significant (p=0.860).

Table 3 Bivariate Analysis of Respondent Characteristics with OSDI scores

	OSDI Score		
Variable	0 – 12	> 13	p value€
Gender			
Men	15(57.7%)	11(42.3%)	0.783
Women	19(61.3%)	12(38.7%)	
Age (year)			
25 – 40	15(62.5%)	9(37.5%)	0.708
>40	19(57.6%)	14(42.4%)	
Serumn level 25(OH)D			
≥30ng/dl	5(45.5%)	6(54.5%)	0.285
<30ng/dl	29(63.0%)	17(37.0%)	

€ = Chi-square test (p<0.05)

Based on Table 3 above, it can be concluded that there is no significant relationship between gender (p=0.783), age (p=0.708), and vitamin D levels (p=0.285) with the OSDI questionnaire.

DISCUSSION

This study aimed to assess the correlation between CO levels and the degree of smoking and lung function in online motorcycle taxi drivers. The median CO level in this study was 7 ppm with the highest value being 36 ppm almost half of the respondents (47.5%) were in the green zone and the remaining 37.3% were in the red zone. Respondents who smoked in this study amounted to 75.7% with a median Brinkman index of 80 and a maximum value of 936. In this study, the average CO level was found to be 12.16 ppm in respondents who smoked, while in those who did not smoke it was 2.76 ppm. Smokers' exhaled CO levels in this study were higher than in similar studies, such as Maga et al (smokers 8.25 ppm vs non-smokers 3.26 pm), but lower than Warsaw et al (smokers 14.4 ppm vs non-smokers 5.1 ppm).[3] In many studies CO levels Expiration in smokers is significantly higher than in non-smokers, but the cut-off point between the two is not yet clear.[7,19] Research in Korea by Kim et al concluded that a cut-point value of 5 ppm has a sensitivity of 80-98.3% with a specificity of 100% in smoking cessation programs for stated that the respondent had stopped completely. If a smoker stops smoking for a long period, his exhaled CO levels can decrease to the same as those of a non-smoker.[19] Research by Cropsey et al even created a cut point of 3 ppm to differentiate smokers from non-smokers, which is considered accurate for all races and does not differentiate between genders. 20 Differences in exhaled CO levels, especially in smokers, can be influenced by many things, such as age, distribution of respondents who are heavy smokers, intensity of exposure to cigarette smoke, depth of inhalation, type of cigarette, last time smoked, or the influence of other factors such as air and environmental pollution.[19, 21] In addition to the cut point for smokers and nonsmokers, some researchers recommend a limit of 10 ppm as a threshold for dangerous CO levels.[19]

The pulmonary function test in this study uses CV and VEP1 parameters to assess whether there is restriction or obstruction. Of the respondents, the results showed that more than half (51.5%) of the respondents experienced restrictive disorders with mild restrictions at 42.4% and 78.8% of respondents experienced obstructive disorders. The results of the spirometry examination were normally distributed with the mean CV and VEP1 between smokers and non-smokers not significantly different, the CV values (79.35% vs 78% with p = 0.732) and VEP1 (55.31% VC 66.96% with p = 0.630). Similar research results were obtained by Saiphoklang et al who did not obtain a significant difference in VEP1 values between smokers and non-smokers (p=0.444).[21]

In the correlation test, it was found that CO levels were significantly positively correlated with the degree of smoking, whether assessed from the Brinkman index or the FTND questionnaire. Expired CO levels have been widely used to assess indicators of the severity of a person's smoking habit.[22] Many studies have been carried out to assess the relationship between exhaled CO levels and smoking habits, the severity of smoking is related to higher expiratory CO levels.[23]

Cigarettes contain thousands of chemicals that are dangerous to humans. Free radicals, nicotine, and CO are believed to have the most dangerous effects. Cigarettes increase CO levels in the blood which will cause various cardiovascular diseases because CO replaces oxygen in the blood to form carboxyhemoglobin /COHb bonds. Measurement of expiratory CO and CoHb levels is a non-invasive and objective measurement to assess the degree of smoking and has been widely used in various studies.[23]

The results of this study did not show a correlation between lung function and exhaled CO levels or the degree of smoking. In experimental tests, there was a significant difference in lung function (KVP and VEP1) before and after smoking shisha (p<0.05). Measurements of lung function and expiratory CO were carried out after the respondents were given treatment to smoke shisha, there was a significant increase in CO and a decrease in lung function before and after the intervention.[9] Soeroso et al, research also found a weak correlation between CO and peak expiratory flow, the higher the CO levels. Expiration will reduce peak expiratory flow (r=-0.26 and p=0.106). [23] Similar results to researchers obtained by Salepci et al, expiratory CO levels were also not found to have a significant correlation with force expiratory flow/ FEF 25-75% ((r =-0.05, p=0.527).[18] This lack of correlation could be caused by several factors including no data on how many cigarettes were smoked in the last 12 hours and how long the respondent had not smoked before the examination.

CONCLUSION

This research found that the heavier the degree of smoking and the higher the nicotine dependence, the higher the exhaled CO levels. There was no correlation between KVP and VEP1 with exhaled CO levels and degree of smoking.

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AUTHORS CONTRIBUTION

RK: Concept, research design, analysis, interpretation of results, and preparation of published articles; RK, MA, DAWS: Data collection, reviewed the article and approved publication.

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CONFLICT OF INTEREST

Competing interests: No relevant disclosures

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