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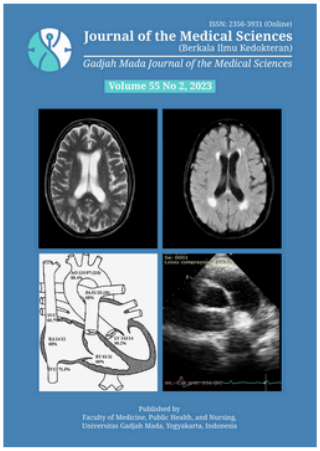

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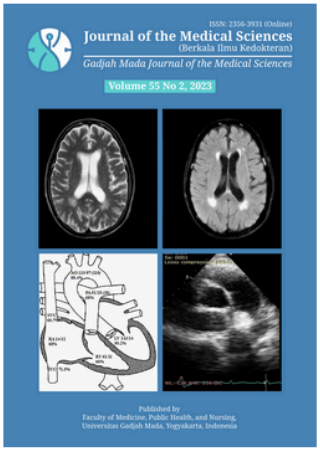

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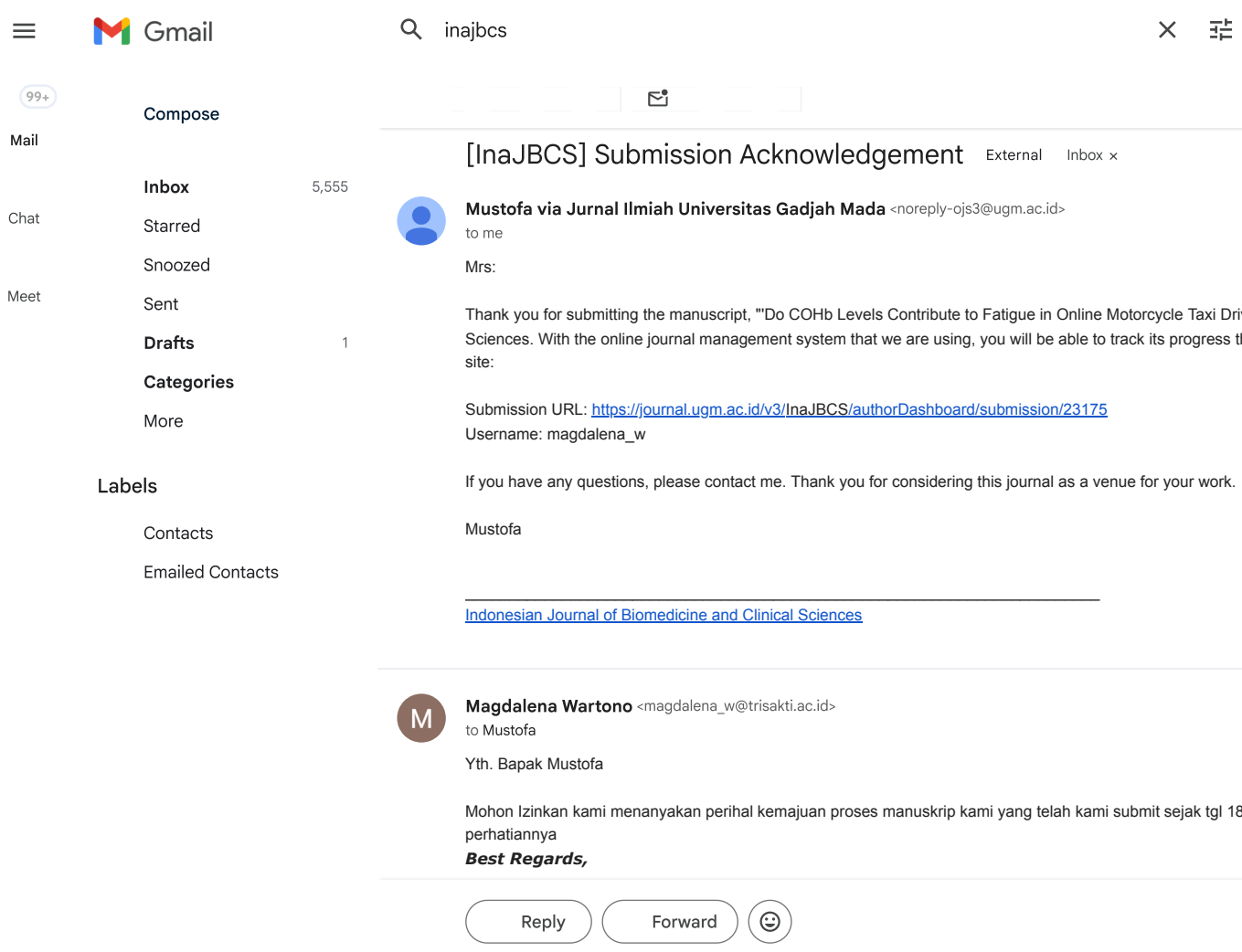
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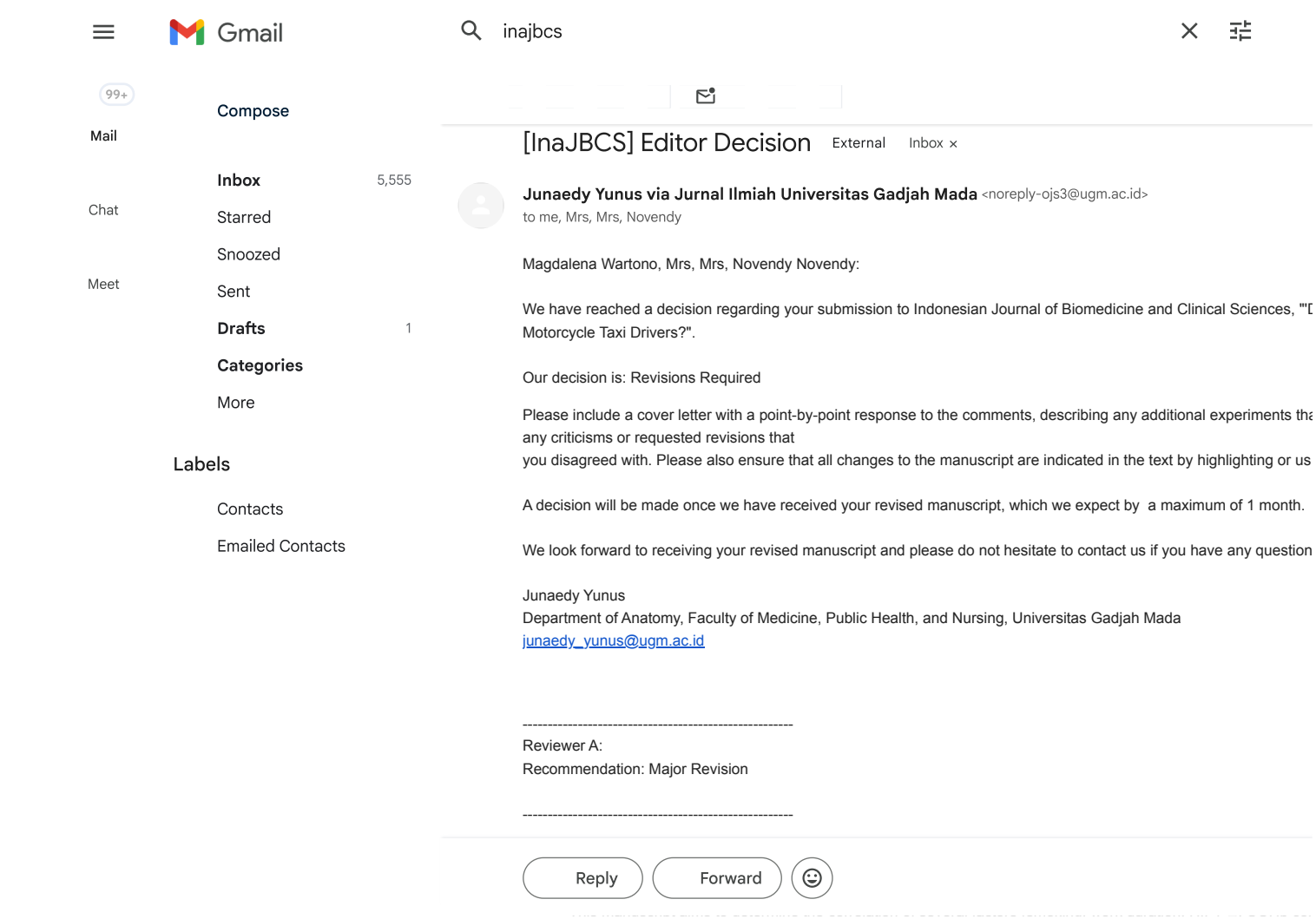
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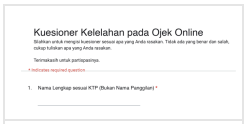

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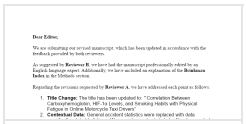
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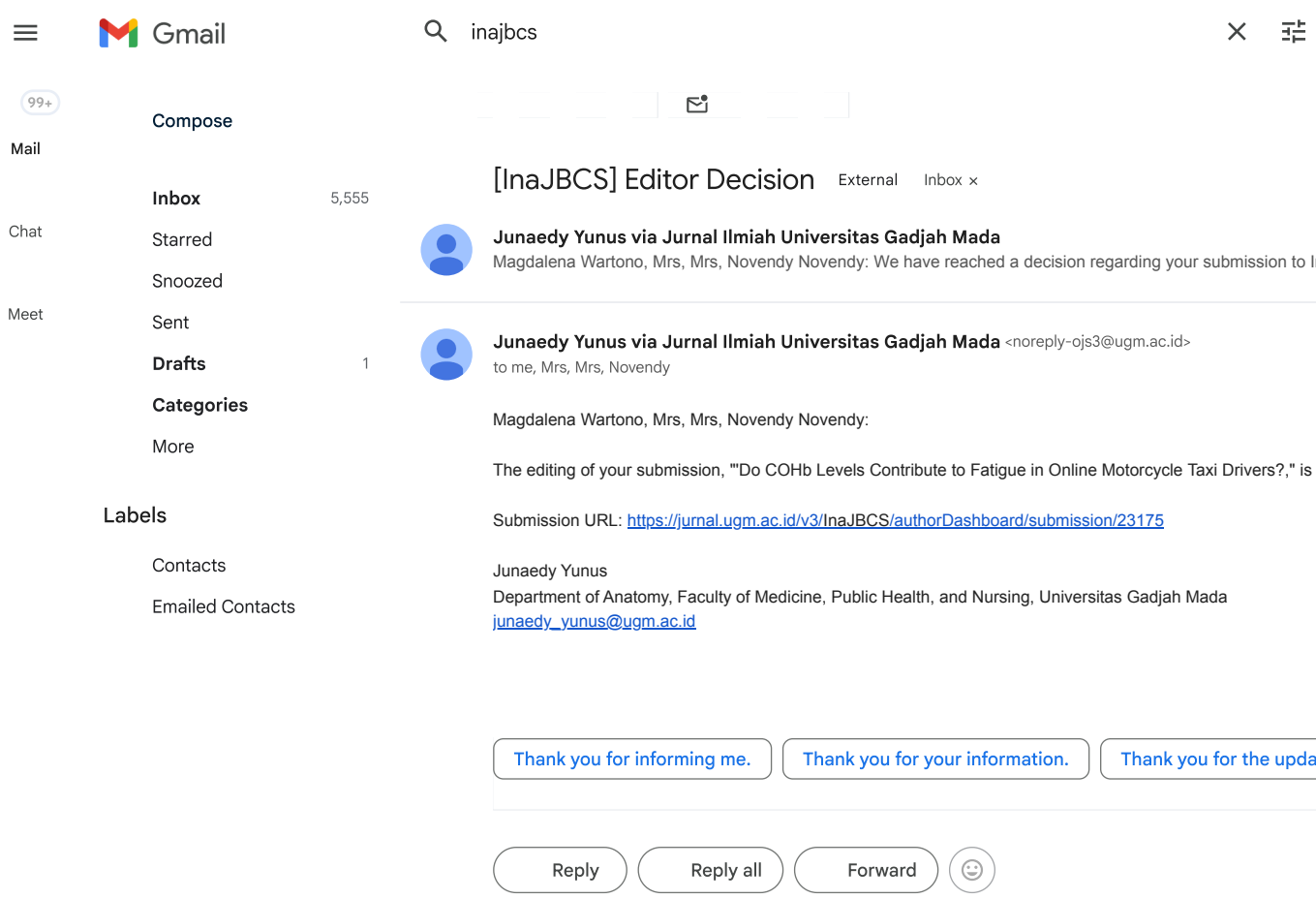
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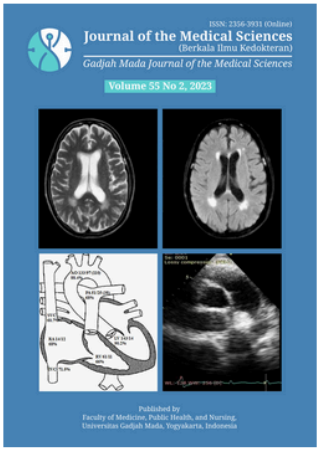

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Correlation between COHb, HIF-1α levels, and smoking habits with physical fatigue in online motorcycle taxi drivers

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ABSTRACT

Online motorcycle taxi drivers have varying working hours and rest periods which can influence the occurrence of fatigue among them. Additionally, working on the road made them exposed to air pollution, including carbon monoxide. Several studies have reported a relationship between carbon monoxide and fatigue levels in specific types of occupations. Therefore, the aim of this study is to determine the correlation between smoking habits, occupational factors, carboxyhemoglobin (COHb) levels, and work fatigue, as well as the correlation between hypoxia inducible factor 1-alpha (HIF-1α) and COHb levels. Demographic characteristics, smoking habits, and occupational factors were measured using a questionnaire. COHb and HIF-1α levels were measured through blood biomarker examinations, while fatigue levels were assessed using the IFRC questionnaire. Data analysis was conducted using Spearman correlation tests in the SPSS program. The results showed that majority of respondents were male (87%), with the highest age range being 19-44 yr (85.5%). More than 50% of respondents were classified as overweight or obese. The majority of them were light smokers (78.3%). Most respondents had normal COHb levels, and in terms of fatigue levels, a larger proportion experienced mild fatigue (66.7%). No correlation between COHb levels, smoking habits, occupational factors, and fatigue levels as well as between HIF-1α and COHb levels ($p>0.05$). In conclusion, no correlation is found between COHb levels, smoking habits, occupational factors, and fatigue levels. Similarly, there is no correlation between HIF-1α and COHb levels.

ABSTRAK

Pengemudi ojek online memiliki jam kerja dan waktu istirahat yang bervariasi, yang dapat menyebabkan kelelahan. Selain itu, bekerja di jalan raya membuat pengemudi terpapar polusi udara, termasuk karbon monoksida. Beberapa penelitian melaporkan adanya hubungan antara karbon monoksida dan tingkat kelelahan pada jenis pekerjaan tertentu. Tujuan penelitian ini adalah untuk mengetahui hubungan antara kebiasaan merokok, faktor pekerjaan, kadar karboksihemoglobin (COHb), dan kelelahan kerja, serta hubungan antara HIF-1α dan kadar COHb. Karakteristik demografis, kebiasaan merokok, dan faktor pekerjaan diukur menggunakan kuesioner. Kadar COHb dan HIF-1α diukur melalui pemeriksaan biomarker darah, sedangkan tingkat kelelahan dinilai menggunakan kuesioner *Industrial Fatigue Research Committee* (IFRC). Analisis data dilakukan dengan uji korelasi Spearman menggunakan program SPSS. Hasil penelitian menunjukkan mayoritas responden laki-laki (87%), dengan rentang usia terbanyak 19–44 tahun (85,5%). Lebih dari 50% responden tergolong kelebihan berat badan atau obesitas. Sebagian besar responden merupakan perokok ringan (78,3%). Mayoritas responden memiliki kadar COHb normal, dan berdasarkan tingkat kelelahan, proporsi terbesar mengalami kelelahan ringan (66,7%). Tidak ditemukan hubungan antara kadar COHb, kebiasaan merokok, faktor pekerjaan, dan tingkat kelelahan, serta antara HIF-1α dan kadar COHb ($p>0,05$). Simpulan, tidak ada hubungan antara kadar COHb, kebiasaan merokok, faktor pekerjaan, dan tingkat kelelahan. Demikian pula, tidak ada hubungan antara HIF-1α dan kadar COHb.

Keywords:
COHb;
HIF-1α;
smoking habits;
work fatigue;
online motorcycle taxi drivers

*corresponding author: magdalena_w@trisakti.ac.id

INTRODUCTION

Online motorcycle taxis, known as *ojek online* had been one of the transportations in Indonesia since 2010. According to the Joint Action Presidium of Two Wheeled Vehicles (Garda) Indonesia, the number of online motorcycle taxi drivers in 2020 was estimated to be around 4 million people, with a quarter of them located in the Jabodetabek area (Jakarta, Bogor, Tangerang, and Bekasi).[1] Motorcycle taxi drivers often work long hours, exposes to weather changes, air pollution, and traffic conditions.[2] Working in such hazardous environments makes them vulnerable to work related health problems.[3]

A study conducted in Vietnam reported that fatigue and lower back pain had been found significantly higher compared to other health issues among motorcycle taxi drivers.[2] Approximately 22.59% of them were reported to experience fatigue. Fatigue is the result of prolonged mental or physical activities that can affect a person's performance and impair their mental alertness, leading to dangerous errors. Fatigue typically refers to a decline in performance. Psychologically, fatigue can be interpreted as not having enough energy to perform work and experiencing a reluctance to continue tasks. Thus, a fatigued individual receives signals from their body that ongoing activities, both physical and mental, should be terminated. Essentially, the effects include a decrease in the capacity to perform mental and physical tasks.[4] Long-term fatigue can have impacts on health, such as musculoskeletal disorders, poor mental health status, and increased errors and accidents in the workplace.[5]

A cohort study of Ahanhanzo *et al.*,[6] in Benin found that fatigue is a significant risk factor for road crashes on two-wheeler especially higher at nighttime. Fatigue has a multidimensional etiology and can originate from both inside and outside the workplace. Fatigue encompasses physical, emotional, behavioral, and cognitive components. Previous research has often discussed job-related factors and sleep-related factors as contributors to work-related fatigue. Monotonous or repetitive work, long working hours, shift work (day or night), work patterns (permanent or rotating), and the duration of shift work have been found to be associated with fatigue. Inadequate work environment factors, such as lighting, temperature, humidity, noise, and ventilation, are also work-related risk factors for fatigue.[7]

A study showed that taxi motorcycle drivers who complained of fatigue are 10.6% among non-smokers and 14.3% among smokers. Although the onset of fatigue can be caused by various factors, complaints such as headaches, irritability, visual perceptual disturbances, fatigue, and hyporeflexia were more frequently found significantly in motorcycle taxi drivers with high levels of carboxyhemoglobin (COHb).[8] With the binding of hemoglobin to CO, tissue oxygenation is disrupted, leading to tissue hypoxia, especially in organs sensitive to oxygen deficiency such as the kidneys, brain, and heart, which can have an impact on a person's health. During hypoxia, the main effector response is hypoxia inducible factor 1-alpha (HIF1-α), a transcription factor. This protein is responsive to low oxygen levels in the cellular environment and accumulates rapidly under hypoxic conditions.[9,10] Due to the significant impact of CO exposure, the study aimed to investigate the correlation between smoking habits, work-related factors (year of service and duration of work), and COHb levels with the fatigue level of online taxi motorcycle drivers. We also intended to examine the correlation between HIF1-α and COHb levels.

MATERIAL AND METHODS

The study was conducted during Covid-19 pandemic period in September 2022 at the Biomedical Laboratory 1, Faculty of Medicine, Universitas Trisakti,

West Jakarta. This research was a cross-sectional approach. The study population consisted of online motorcycle taxi drivers working in Jakarta and its surroundings. The subjects were 69 online motorcycle taxi drivers who had been working for at least 1 year and were willing to sign an informed consent. The exclusion criteria included online motorcycle taxi drivers with chronic respiratory diseases such as chronic obstructive pulmonary disease or other chronic conditions such as heart failure, kidney failure, and malignancy. This study has obtained ethical clearance issued by the Faculty of Medicine, Universitas Trisakti with number 162/KER/FK/VIII/2022.

Questionnaire

The data collected in this study were primary data obtained using a questionnaire that assessed sociodemographic characteristics like age, sex, and respondents' occupations (years and duration of work). The smoking habits were assessed using the Brinkman Index by multiplying the quantity of cigarettes smoked per day by the total duration of the smoking habit in years. The results were classified as light (0-199), moderate (200-599) and heavy smoker (>600). Body mass index (BMI) was obtained by measuring body weight (BW) in kg and height (H) in m and were calculated using a formula (BMI = BW/H^2). The classification of BMI was according to World Health Organization (WHO) for Asian.

Fatigue level assessment

Fatigue level assessment was conducted through interviews using the Industrial Fatigue Research Committee (IFRC) questionnaire.[11] The classification used was as follows:

Examination of COHb levels

The COHb level were obtained from venous blood sample. The blood was collected using a 3 mL no anticoagulant red-top vacutainer tube. The sample was then placed in an icebox at a temperature of 11.7°C and stored in a refrigerator overnight. The examination of COHb levels using the Conway diffusion method was conducted at Prodia Laboratory. The reference values for COHb levels are <1.50% for non-smokers and 3-15% for smokers based on the reference provided by the laboratory.

Examination of HIF-1α

Human hypoxia-inducible factor 1-alpha (HIF-1α) in serum is measured using The InvitrogenTM HIF-1 Alpha ELISA Kit from ThermoFisher, Austria, conducted at Prodia Laboratory.

Data analysis

Univariate analysis is performed by describing the research results following the principles of descriptive statistics and presenting them in a frequency distribution table. Bivariate analysis is conducted using the Spearman correlation formula due to the non-normal distribution of the data. Data analysis is performed using SPSS 21.0 software for Windows. A p value < 0.05 is considered significance.

RESULTS

This study was conducted on 69 respondents consisting of online motorcycle taxi drivers from various areas in Jakarta and its surroundings. Out of the 69 respondents, 87% were male drivers, with the majority falling within the age range of 19-44 yr (85.5%). More than 50% of the respondents were classified as overweight or obese. The majority of them were light smokers (78.3%). Most of the respondents had normal COHb levels, and in terms of fatigue levels, the majority experienced mild fatigue (66.7%), none of them experienced high level of fatigue (TABLE 2)

TABLE 1. Classification of subjective fatigue level based on total score.[11]

Fatigue level	Individual total score	Fatigue classification	Improvement measurement
1	30 – 52	Low	No improvement action is required.
2	53 – 75	Medium	Improvement action may be required in the future.
3	76 – 98	High	Immediate action is required.
4	99 – 120	Very high	Comprehensive action is required as soon as possible.

TABLE 2. Frequency distribution of subject characteristics in the study

Variables	Frequency (n)/ median (range)	Percentage (%)
Sex		
Male	60	87
Female	9	13
Ages (yr)		
19 – 44	59	85.5
45 – 59	9	13
≥ 60	1	1.4
Body mass index		
< 18.5	6	8.7
18.5 – 22.9	20	29
23 – 24.9	7	10.1
25 – 29.9	18	26.1
≥ 30	18	26.1
Smoking habit (Brinkman index)		
Light (0 – 199)	54	78.3
Moderate (200 – 599)	14	20.3
Heavy (≥ 600)	1	1.4
Years of service (yr)	5 (1 – 11)	-
Duration of work (hr/d)	12 (1 – 16)	-
HIF1-α (pg/mL)	4.9 (2.58 – 72.09)	-
COHb level (%)	0.39 (0.10 – 6.70)	-
COHb level ategories		
Normal	48	69.6
Not Normal	21	30.4
Fatigue level		
Low (30 – 52)	46	66.7
Medium (53 – 75)	23	33.3
High (76 – 98)	0	0
Very High (99 – 120)	0	0

Regarding the normality test of the data, the Kolmogorov-Smirnov test was used since the sample size was only 69. All variable data had a non-normal distribution ($p > 0.05$). Therefore, the Spearman correlation test was used to analyze the correlation between non-parametric data.

TABLE 3 shows that among all examined parameters (age, BMI, smoking habit, work duration, length of service, COHb concentration), there were no correlations between these parameters and fatigue level. The analysis results between HIF1-α and COHb levels also did not show any correlation between these two variables (TABLE 4).

TABLE 3. Correlation between demographic characteristics, occupational factors, COHb levels, and fatigue levels in online motorcycle taxi drivers.

Variable	Fatigue level	
	r	p*
Ages	0.159	0.192
BMI	0.127	0.299
Smoking habit	0.116	0.345
Working hours	0.052	0.673
Duration of employment	-0.039	0.749
COHb level	-0.42	0.735

*Spearman's correlation test

TABLE 4 Correlation between HIF1-**α** and COHb levels

Variable	COHb levels	
	r	p*
HIF1-a	-0.017	0.192

*Spearman's correlation test

DISCUSSION

Just like a study in Taiwan, there were more men working as food delivery riders compared to women (74% vs 26%). Similarly, in this study, male respondents were more dominant. In terms of age range, there was not much difference compared to Chen's study where the age range of online motorcycle taxi drivers was 31-50 yo.[12] The median duration of work per day for the study subjects was 12 hr, like online motorcycle taxi drivers in Medan who have an average of 12 hy of work per day.[13] The CO levels in the blood of the respondents mostly fell into the normal category. During the data collection in September 2022, the concentration of CO in the air in Jakarta ranged from 0.58 to 2.34 mg/m^3, which is below the safe limit of 10 mg/m^3. Therefore, the amount of CO concentration exposure was not significant.[14] The results showed that 66.7% of the respondents experienced mild fatigue, similar to the study in Bekasi where most of online motorcycle taxi drivers experienced mild fatigue (50.9%).[15] In Indonesia, there are three online motorcycle companies where the drivers do not have fixed working hours; they can work as they please. As a result, the duration of work and rest varies greatly, which certainly affects the fatigue level of online motorcycle taxi drivers. However, a study in Depok found that 43% of the surveyed online motorcycle taxi drivers had experienced near-missed accidents, and one of the causes was fatigue, although the level of fatigue, whether mild or moderate, was not specified.[16]

In this study, smoking habits were not correlated with the level of fatigue. This is different from a study in Turkey which found that in smokers, the total fatigue scores were higher than in non-smokers ($p<0.05$).[17] Similarly, a study by Li *et al*.[18] demonstrated that subjects who still smoked had nearly twice the risk of experiencing fatigue (OR=1.956). The nicotine content in cigarettes can lead to a state of decreased energy (fatigue) characterized by a decrease in energy intake and an increase in energy expenditure. Energy intake and expenditure depend on regulation in the brain. Nicotine can affect energy expenditure by increasing the release of norepinephrine, serotonin, and other factors. These factors influence the brain to modify appetite and metabolic rate.[19] Another study by Corwin[20] reported that research subjects who were heavy smokers tended to experience fatigue, while in this study, there were more subjects who belonged to the group of light smokers.

There was no correlation between work hours and duration of employment with the level of fatigue ($p>0.05$). Consistent with a study on online motorcycle taxi drivers in Bekasi, work duration and duration of employment were not significantly associated with the occurrence of fatigue in the respondents ($p>0.05$), but were related to previous medical history.[15] This is different from the findings of a study by Ferusgel *et al*.,[13] which demonstrated a relationship between work duration and the level of fatigue, as indicated by increased blood lactate levels. Workers with longer employment tend to experience work fatigue more frequently due to declining stamina, especially caused by boredom.[21,22]

The COHb levels in this study were also not correlated with the level of fatigue. This differs from a study by Carter, which found a significant association between fatigue and the level of CO concentration in the air on the same day ($p=0.001$). However, this significance was only observed in subjects who experienced physical complaints within a year, as these subjects experienced concurrent immune and inflammatory disturbances that could contribute to physical fatigue.[23] In this study, subjects

with chronic diseases were excluded, and the CO levels in the air during the study were within the permissible limits.

The analysis results between HIF1-α and COHb levels also did not show any correlation between these two variables. The binding of Hb with CO can reduce tissue oxygenation capacity.[24] Intermittent hypoxia stimulates the carotid body, inducing the formation of reactive oxygen species (ROS) and increasing intracellular Ca2+ levels, both of which enhance the expression of hypoxia-inducible factor HIF-1α.[10] Significant CO exposure increases COHb concentrations above 10% and CO poisoning is twice as likely at that level.[25] However, in this study, the median COHb level was 0.39 (0.1-6.7) %, which showed the subjects were not significantly exposed to CO.

No significant correlation was found between the measured parameters and fatigue levels in online motor taxi drivers, suggesting these factors remain within tolerable limits. Nevertheless, with 33.3% of the population reporting moderate fatigue, preventative measures are essential to avoid more severe conditions. Intervention strategies should focus on health education, specifically regarding respiratory protection, smoking cessation, nutrition, and sufficient recovery time.

Some limitations were observed in this study such as fatigue levels were still subjectively measured using a questionnaire and did not include muscle fatigue biomarkers, nor did it exclude mental fatigue. Blood samples for COHb level examination were not taken after work, and during data collection, the air pollution levels in Jakarta were still categorized as good due to the pandemic period. The strength of this study is the previous research on COHb and HIF-1α levels among online motorcycle taxi drivers in the Jakarta area were scarce.

CONCLUSION

This study shows no correlation between smoking habits, occupational factors and COHb levels with fatigue levels among online motorcycle taxi drivers. Similarly, there is no correlation between the hypoxia expression factor HIF-1α and COHb levels. For future research, it is recommended to measure COHb levels and fatigue levels before and after work, accompanied by a comparison with air pollution levels.

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