Determining Factors for Smoking Habits and FeNO Levels in Male College Student Smokers

Irfan Hasyim Tadjoedin[1] [ID], **Adityo Wibowo[2]** [ID], **Triya Damayanti[3*]** [ID]
[1]Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia.
[2]Department of Respiratory Medicine, Graduate School of Medicine, Juntendo University, Tokyo, Japan.
[3]Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Indonesia/Persahabatan National Respiratory Referral Hospital, Jakarta, Indonesia.

ARTICLE INFO

ABSTRACT

Introduction: Smoking remains a pervasive and persistent health issue in Indonesia. Numerous studies have explored the impact of smoking and fractional exhaled nitric oxide (FeNO) levels on college students. However, none have been conducted in Indonesia. With a substantial number of smokers and teenage smokers in the country, there is a critical need to understand the implications of smoking. This study aimed to enhance the comprehension of the motivations behind smoking habits and, consequently, to devise more effective smoking cessation programs. It specifically sought to elucidate the relationship between smoking habits and exhaled nitric oxide (NO) levels among college students and to explore the reasons why students smoke.
Methods: This study employed analytical and descriptive cross-sectional approaches. We interviewed 124 participants, 30 of whom were randomly selected for FeNO-level testing.
Results: The mean age of the subjects was 20.1 ± 1.54 years old. Of these, 48 (38.7%) were enrolled in science and technology programs and 76 (61.3%) in social sciences. The Brinkman index predominantly indicated a mild level of smoking (96.8%), with a moderate level observed in 3.2% of the subjects. The median FeNO level was 12 ppb. According to the Horn questionnaire, the most cited reasons for smoking were pleasure (71%), followed by stress relief (66.1%) and stimulation (38.7%). No significant correlation was found between the Brinkman index and FeNO levels.
Conclusion: The primary factors influencing smoking habits among the subjects were stress relief and the pleasure derived from smoking. No correlation was observed between smoking habits and exhaled NO levels.

INTRODUCTION

Smoking is a pervasive and persistent health problem in Indonesia. A significant 34.8% of the population smokes daily.[1] This finding is supported by studies indicating that Indonesia has the fifth-largest cigarette market in the world, consuming 182 billion cigarettes annually. The government's reluctance to sign the World Health Organization (WHO) Framework Convention on Tobacco Control (WHO FCTC) is concerning, as it could exacerbate this trend.[2] Smoking has become normalized across various groups in Indonesia. A considerable number of adults—67% of all men and 2.7% of all women—are smokers, amounting to 59.9 million people or 34.8% of the total adult population.[2,3]

Cigarette smoking induces oxidative stress, contributing to chronic obstructive pulmonary disease (COPD). The protease–antiprotease imbalance caused by smoking leads to COPD and can result in emphysema. Other diseases linked to smoking include chronic bronchitis, pulmonary hypertension, and asthma.[4] Nitric oxide (NO) is a predominant substance found in cigarettes, along with other toxic components such as hydrocarbons, ketones, and aldehydes.[5] Under normal circumstances, NO acts as a vasodilator in the lungs. However, in smokers, NO levels increase due to the NO produced from smoking and increased nicotine in the brain. Consequently, basal endogenous NO synthesis decreases in smokers' airways and blood vessels.[6,7]

Fractional exhaled nitric oxide (FeNO) is a method for measuring NO levels in the respiratory tract. FeNO is measured by blowing air into a specially designed breathalyzer, providing an overview of the subject's health condition and smoking habits.[8]

Various factors influence cigarette consumption. Several important factors can affect a person's smoking behavior. The motivation for smoking can be differentiated using methods such as the Horn questionnaire. Horn, *et al.* (1969) categorized cigarette use into six groups: pleasurable relaxation, stimulation, sensorimotor manipulation, negative affect, habitual, and addictive.[9] These six factors represent the primary reasons behind smoking and inform methods for smoking cessation treatment. These factors were compiled into a questionnaire to provide deeper insights into the reasons for smoking.[9]

Addiction is one of the factors in smoking. It is a feature of tobacco abuse and can indicate relapse. Cigarette addiction may activate several brain regions associated with planning and regulation processes, emotional responses, and automatic behavior. However, conclusions cannot be drawn definitively due to the heterogeneity of results stemming from various individual factors, such as genetics and quitting factors, as well as methodological factors, including self-regulation and abstinence from smoking.[10]

A study on NO levels in student smokers has been conducted in Saudi Arabia.[11] However, no similar investigation has been performed in Indonesia. Therefore, this study aimed to examine the relationship between smoking and FeNO levels in university students in Indonesia. Additionally, further understanding of the reasons for smoking among Indonesian university students is needed to aid efforts to reduce smoking in this population.

METHODS

This study employed a cross-sectional descriptive analysis method to observe the relationship between cigarette use frequency and FeNO levels. The research was conducted between July and August 2019 at a university in Depok, West Java. It was approved by the Research Ethics Commission, Faculty of Medicine, Universitas Indonesia (No.KET-864/UN2.F1/ETIK/PPM.00.02/2019). The participants were all male undergraduate students at a university in the Depok area who smoked cigarettes.

The exclusion criteria included subjects who were unable to perform the breathalyzer maneuver or unwilling to complete the Horn questionnaire for smoking reasons. The Horn questionnaire consisted of 18 questions designed to determine the level and types of addiction influencing the decision to smoke. The FeNO measurement was conducted using a Bedfont NObreath breathalyzer.

Other variables measured included the subject's socioeconomic condition, education, and the influence of close people who also smoked. The socioeconomic condition was defined by the subject's monthly income, regardless of its source (pocket money, job, and others), reported in rupiah (Rp). The major of studies was categorized into social studies or science and technology. The influence of close people who smoked was divided into two groups: family (father, mother, and/or siblings) and closest friends.

A total of 116 male university students who were active smokers participated in the smoking behavior study, with 30 students randomly selected for the FeNO measurement study. Data was analyzed using the Spearman bivariate correlation. Sampling for the smoking behavior study continued until the minimum sample size calculated by the sample size formula was reached. Meanwhile, the FeNO measurement test subjects were randomly selected from the smoking behavior study participants.

RESULTS

This research involved 124 subjects, categorized into demographic data, as shown in Table 1. A total of 81 of the subjects had at least one family member who smoked: fathers of the subject who also smoked were found in 58 subjects (71.6%), mothers in 7 subjects (8.6%), and siblings in 35 subjects (43.2%).

132

J. Respi. May 2024, Vol. 10 (02); 130-136

Table 1. Demographic data

Variable	n	%	Mean
Age			20.1 ± 1.54
Major			
Science and technology	48	38.7	
Social studies	76	61.3	
Income (monthly)			
<Rp.2.000.000,00	28	22.6	
Rp.2.000.000,00–Rp.4.000.000,00	46	37.1	
Rp.4.000.000,00–Rp.6.000.000,00	16	12.9	
>Rp.6.000.000,00	34	27.4	
Close relations with people who also smoke			
Family	81	65.3	
Close friends	123	99.2	

Various variables are considered when monitoring smoking habits. One way to measure the extent of smoking habits is using the Brinkman index, calculated by multiplying the number of cigarettes consumed daily by the length of smoking in years (Table 2).

Table 2. Result of the measurement of the Brinkman Index on Subjects

Brinkman Index	n	%
Mild	120	96.8
Moderate	4	3.2
Severe	0	0

FeNO levels were measured in 30 randomly selected subjects from 124 subjects who were assessed using the Brinkman Index. The measurement was conducted using a standardized FeNO measuring device. Of the 30 selected subjects, one dropped out due to resignation, leaving 29 datasets (Table 3).

Table 3. FeNO measurement results

	Median (ppb)	Min.	Max.
FeNO level	12	4	98

Data analysis was performed using the Spearman coefficient to determine the bivariate relationship between smoking habits and FeNO levels. The Spearman test was used due to the abnormal distribution of FeNO data ($\rho > 0.005$). The correlation coefficient between the FeNO level and the Brinkman index ($r = -0.123$; $p > 0.05$) indicated a negative correlation that was not significant between the two variables.

Factors influencing smoking were analyzed based on the Horn questionnaire, which divides smoking factors into seven categories: stimulation, pleasure, craving, grip, habit, stress relief, and social. Each category is represented by three questions answered on a scale of 1–5. If the total score of the three questions is 10 or above, this indicates that this factor affects the subject. Table 4 shows the results based on the Horn questionnaire.

Table 4. Horn questionnaire results

Categories	n	%
Stimulation	48	38.7
Pleasure	88	71
Craving	43	34.7
Grip	45	36.3
Habit	45	36.3
Stress relieve	82	66.1
Social	47	37.9

The Horn questionnaire data, which concerned the study program background and the monthly earnings of each subject, were then examined, resulting in Figure 1 and 2.
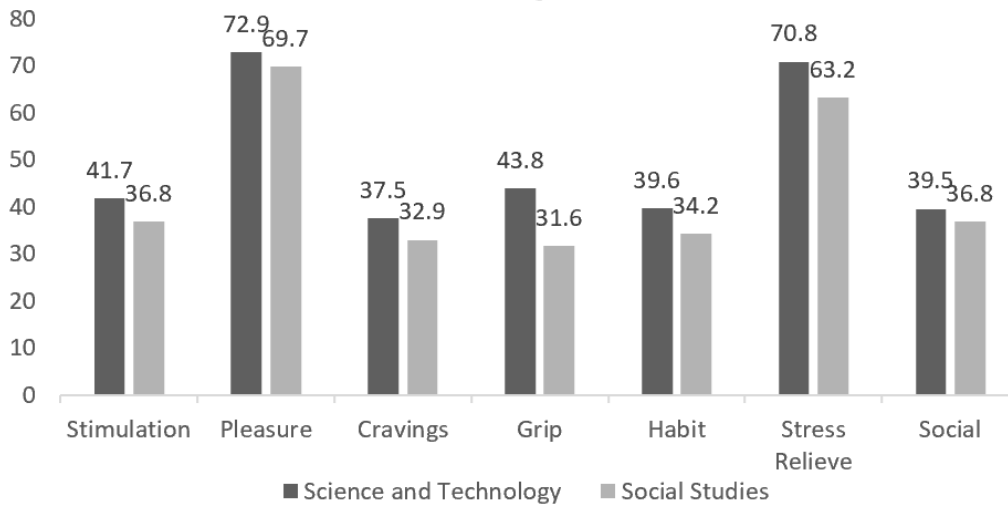
133

J. Respi. May 2024, Vol. 10 (02); 130-136

Figure 1. Horn questionnaire results based on the background of majors (in percent)
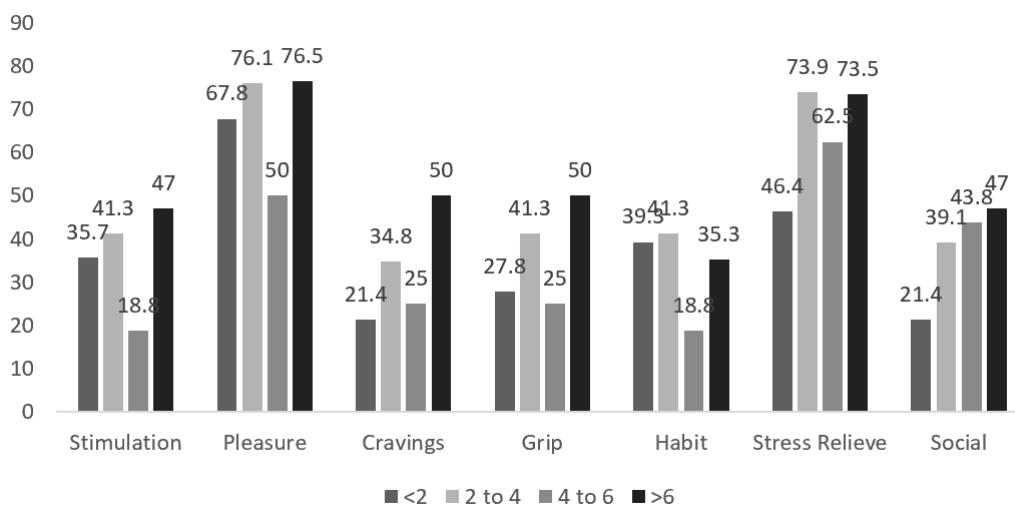

Figure 2. Horn questionnaire results based on the monthly earnings of subjects (in million Rps [in percent])

DISCUSSION

The smoking habits of parents may influence the smoking habits of college students. In this study, 71.6% of the participants had fathers who also smoked, and 8.6% had mothers who smoked. Parents play a substantial role in shaping their offspring's attitudes, beliefs, and behaviors toward smoking. Parental behavior at home is also considered influential on their children's smoking behavior, aligning with the social learning model. Studies found that fathers who smoke and care for their children have offspring who smoke at a higher prevalence compared with offspring of fathers who smoke but do not care for their children.[12,13]

Additionally, 99.2% of the subjects had at least one close friend who also smoked. It is important to note that the average student began actively smoking before college. This finding is supported by previous research, which highlights the ineffectiveness of student-to-student initiation of smoking.[14] However, research on

this matter remains debatable, as other studies suggest that smoking initiation often begins within friendship circles during adolescence, with the continuation of the habit linked to those with the closest relationships to the subject.[15,16]

Income information in this study can be contextualized within the subjects' socioeconomic status. According to the study by Haustein, *et al.* (2006), poverty is strongly associated with an increased likelihood of smoking initiation, progression, and a reduced likelihood of quitting.[16] Furthermore, global research indicates that children from low-income families are more likely to spend money on cigarettes compared with children from higher-income families.[16]

This study found that the income distribution was dominated by subjects with monthly incomes ranging from Rp.2.000.000,00 to Rp.4.000.000,00, representing 37.1% of participants. Meanwhile, Indonesia's poverty line was set at Rp.425.250,00 per capita per month as of March 2019.[17] This indicates that individuals with

incomes below Rp.2.000.000,00 per month, constituting 22.6% of the subjects fall below the poverty line. These results contradict previous studies and suggest that factors beyond poverty may further influence smoking habits.

A total of 96.8% of the subjects were classified as light smokers according to the Brinkman index. This finding aligns with the study by Amelia, *et al.* (2016), which also indicated a prevalence of light smokers in the 15–24 age group.[18] In contrast, older subjects were found to have moderate or severe Brinkman index scores, with the highest scores observed in the 35–44 and 45–54 age groups, respectively.[18] This discrepancy may be due to two factors: the small number of cigarettes consumed by the younger subjects or the relatively short duration of their smoking history, which has not been long enough to increase their Brinkman index scores. The context of smoking duration is related to a previous study by Haddad, *et al.* (2002), which suggested that most smokers began active smoking at the age of 15 years old.[19] Consequently, the low Brinkman index scores found in students are reasonable, as their smoking history has not been long enough to show high severity on the index.

This study showed that the subjects' median and mode FeNO levels were 12 ppb, with a minimum value of 4 ppb and a maximum value of 98 ppb. This result is consistent with previous studies by Habib, *et al.* (2011) and McSharry, *et al.* (2005), who found that FeNO levels in smokers were substantially lower compared with non-smokers.[20] Additionally, these results align with the recommendations of the American Thoracic Society, which stated that FeNO levels in smokers tend to be below 25 ppb.[8]

Several theories have been proposed to explain this phenomenon. The mechanism behind the decrease in FeNO due to smoking is still under investigation. Khartionov, *et al.* (1995) mentioned that NO can decrease the activity of NOS. Thus, the high NO levels in cigarettes may result in a negative feedback response that reduces NO production activity in the airways, leading to decreased FeNO levels.[21] Meanwhile, Balint, *et al.* (2001) attributed the low FeNO levels in smokers to the ability of cigarettes to modulate NO metabolism.[22] This may occur due to cigarettes' ability to facilitate NO oxidation, which is associated with the generation of transient oxidative products and the harmful effects of smoking.[22]

The data analysis showed no substantial correlation between the Brinkman index and FeNO levels. This may indicate no change in the risk of decreasing FeNO levels with the amount or duration of smoking. However, the absence of a substantial correlation may also be due to the small number of subjects and/or the abnormal distribution of the FeNO data. These results contradict the findings of McSharry, *et al.* (2005), who stated that FeNO levels are associated with smoking duration and the number of cigarettes consumed.[20] Similar findings were also reported by Kharitonov, *et al.* (1995), who found a correlation between FeNO levels, the number of cigarettes smoked per day, and the length of smoking in years.[21] Conversely, the study by Habib, *et al.* (2011) supports the findings of this study, showing no correlation between FeNO levels and smoking duration or the number of cigarettes consumed per day.[11]

This study found that the majority of subjects associated smoking with factors related to pleasure (71%) and stress relief (66.1%). This result is consistent with the studies of Souza, *et al.* (2010), See, *et al.* (2019), and Sawitri, *et al.* (2020), which stated that the majority of smokers tend to smoke due to factors related to pleasure, stress relief, and addiction.[23–25] The pleasure derived from smoking was highlighted in the study by McEwen, *et al.* (2008), which mentioned that the pleasure factor can be considered the initiation point of the smoking habit and becomes the default state of smoking.[26] The transition from smoking for pleasure to stress relief typically occurs at the beginning of the smoking habit.[26] Meanwhile, several studies suggest the stress-relieving function of cigarettes. Haddad, *et al.* (2002) attributed smoking to stress relief from the pressures of a college environment, the emergence of "adult" status among student subjects, and the distance from parents.[19] This study also found that social factors play an important role in the continuation of smoking among college students.[19] Choi, *et al.* (2015) concluded that there was a relationship between decreased stress and reduced stress stimulation in smoking subjects compared with non-smoking subjects.[27]

LIMITATIONS

The primary limitation of this study was the small number of subjects who underwent the FeNO examination due to limited funds. Additionally, the cross-sectional research method used in this study has inherent limitations, such as the inability to evaluate the continuity of a subject's progress and the inability to establish causal relationships.

CONCLUSION

This study found that most subjects were in the field of social sciences and that most subjects had an income between two and four million. Most of the subjects had close friends who also smoked. However, no substantial correlation was found between the subjects' FeNO levels and the Brinkman index. Another

interesting finding of this study was that the factors that most influence smoking behavior in subjects were pleasure and stress relief. There have been few reports on the reasons for smoking among young smokers in Indonesia. Understanding these reasons is crucial for tackling the smoking epidemic in Indonesia, as they can serve as references for developing more effective smoking cessation treatments for the younger generation.

Authors' Contributions
Conceptualization: TD, IHT, and AW. Data curation: IHT and TD. Formal analysis: IHT andTD. Funding acquisition: None. Methodology: TD and IHT. Project administration: TD and IHT. Writing (original draft): IHT, TD, and AW. Writing (review and editing): IHT, TD, and AW.

REFERENCES
1. (WHO) WHO. *WHO Report on the Global Tobacco Epidemic 2019: Offer Help to Quit Tobacco Use.* Geneva, https://www.who.int/publications/i/item/978924151 6204 (2019).
2. Asia WHORO for S-E. WNTD: Indonesia Factsheet, https://iris.who.int/handle/10665/272673 (2018).
3. Nichter M, Padmawati S, Danardono M, *et al*. Reading Culture from Tobacco Advertisements in Indonesia. *Tob Control* 2008; 18: 98–107. [ResearchGate]
4. (US) C for DC and P, (US) NC for CDP and HP, (US) O on S and H. *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General.* Atlanta (GA), 2010. [PubMed]
5. Robbins RA, Grisham MB. Nitric Oxide. *Int J Biochem Cell Biol* 1997; 29: 857–860. [PubMed]
6. Vleeming W, Rambali B, Opperhuizen A. The Role of Nitric Oxide in Cigarette Smoking and Nicotine Addiction. *Nicotine Tob Res* 2002; 4: 341–348. [PubMed]
7. Ricciardolo FLM. Multiple Roles of Nitric Oxide in the Airways. *Thorax* 2003; 58: 175–182. [PubMed]
8. ATS/ERS Recommendations for Standardized Procedures for the Online and Offline Measurement of Exhaled Lower Respiratory Nitric Oxide and Nasal Nitric Oxide, 2005. *Am J Respir Crit Care Med* 2005; 171: 912–930. [PubMed]
9. Ikard FF, Green DE, Horn D. A Scale to Differentiate between Types of Smoking as Related to the Management of Affect. *Int J Addict* 1969; 4: 649–659. [Journal]
10. Potvin S, Tikàsz A, Dinh-Williams LL-A, *et al*. Cigarette Cravings, Impulsivity, and the Brain. *Front Psychiatry* 2015; 6: 125. [PubMed]
11. Habib SS, Ahmed SM, Al Drees AM, *et al*. Effect of Cigarette Smoking on Fractional Exhaled Nitric Oxide in Saudi Medical College Students. *J Pak Med Assoc* 2011; 61: 120–123. [PubMed]
12. Gilman SE, Rende R, Boergers J, *et al*. Parental Smoking and Adolescent Smoking Initiation: An Intergenerational Perspective on Tobacco Control. *Pediatrics* 2009; 123: e274-81. [PubMed]
13. Astuti K. Gambaran Perilaku Merokok pada Remaja di Kabupaten Bantul. *INSIGHT* 2012; 10: 77–87. [Journal]
14. Von Ah D, Ebert S, Ngamvitroj A, *et al*. Factors Related to Cigarette Smoking Initiation and Use among College Students. *Tob Induc Dis* 2005; 3: 27–40. [PubMed]
15. Kobus K. Peers and Adolescent Smoking. *Addiction* 2003; 98 Suppl 1: 37–55. [PubMed]
16. Haustein K-O. Smoking and Poverty. *Eur J Cardiovasc Prev Rehabil* 2006; 13: 312–318. [PubMed]
17. Timur BPSPJ. *Kemiskinan dan Ketimpangan*. Surabaya, https://jatim.bps.go.id/subject/23/kemiskinan-dan-ketimpangan.html#subjekViewTab1.
18. Amelia R, Nasrul E, Basyar M. Hubungan Derajat Merokok Berdasarkan Indeks Brinkman dengan Kadar Hemoglobin. *J Kesehat Andalas*; 5. Epub ahead of print 1 September 2016. [Journal]
19. Haddad LG, Malak MZ. Smoking Habits and Attitudes towards Smoking among University Students in Jordan. *Int J Nurs Stud* 2002; 39: 793–802. [PubMed]
20. McSharry CP, McKay IC, Chaudhuri R, *et al*. Short and Long-Term Effects of Cigarette Smoking Independently Influence Exhaled Nitric Oxide Concentration in Asthma. *J Allergy Clin Immunol* 2005; 116: 88–93. [PubMed]
21. Kharitonov SA, Robbins RA, Yates D, *et al*. Acute and Chronic Effects of Cigarette Smoking on Exhaled Nitric Oxide. *Am J Respir Crit Care Med* 1995; 152: 609–612. [PubMed]
22. Balint B, Donnelly LE, Hanazawa T, *et al*. Increased Nitric Oxide Metabolites in Exhaled Breath Condensate after Exposure to Tobacco Smoke. *Thorax* 2001; 56: 456–461. [PubMed]
23. Souza EST de, Crippa JA de S, Pasian SR, *et al*. University of São Paulo Reasons for Smoking Scale: A New Tool for the Evaluation of Smoking Motivation. *J Bras Pneumol* 2010; 36: 768–778. [PubMed]

136

J. Respi. May 2024, Vol. 10 (02); 130-136

24. Sawitri H, Maulina F, Aqsa R. Karakteristik Perilaku Merokok Mahasiswa Universitas Malikussaleh 2019. *AVERROUS J Kedokt dan Kesehat Malikussaleh* 2020; 6: 75. [Journal]

25. See JHJ, Yong TH, Poh SLK, *et al*. Smoker Motivations and Predictors of Smoking Cessation: Lessons from an Inpatient Smoking Cessation Programme. *Singapore Med J* 2019; 60: 583–589. [PubMed]

26. McEwen A, West R, McRobbie H. Motives for Smoking and Their Correlates in Clients Attending Stop Smoking Treatment Services. *Nicotine Tob Res* 2008; 10: 843–850. [PubMed]

27. Choi D, Ota S, Watanuki S. Does Cigarette Smoking Relieve Stress? Evidence from the Event-Related Potential (ERP). *Int J Psychophysiol* 2015; 98: 470–476. [PubMed]