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Effect of Degree of Smoking Based on Brinkman Index on Hemoglobin Levels in Adults

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A B S T R A C T

Cigarette consumption is the main cause of death in the world because it affects various physiological conditions in the body. Various ingredients in cigarette smoke such as tar, nicotine, carbon monoxide, and others can cause health problems, especially in the O_2 transportation system. Hemoglobin is a protein in red blood cells that carries oxygen from the lungs to all tissues. The carbon monoxide contained in cigarette smoke is competitive with O_2 in binding to hemoglobin so that the oxygen distributed to the tissues is reduced. The body will compensate for peripheral hypoxia that occurs by increasing hemoglobin levels in the body so that oxygen transport to the tissues can be maintained. Research regarding the relationship between the degree of smoking and hemoglobin levels is still controversial. Analytical research with cross-sectional design. A total of 184 respondents were taken using purposive sampling and it was found that the majority (94%) were men who worked as security officers, cleaners, parking attendants, or technicians. Based on the Brinkman Index, 73.9% of respondents were classified as light smokers, only 1.6% were classified as heavy smokers and 50.5% of respondents had low hemoglobin levels. Analysis showed that the majority of respondents in the light smoker group had normal hemoglobin levels (58.1%), while moderate and heavy smokers had lower hemoglobin levels. In statistical analysis, a significant p-value (0.001) was found between the degree of smoking and hemoglobin levels.

1. Introduction

Cigarettes are a tobacco product that uses additional materials such as paper or pure tobacco without additional ingredients.[1] Cigarettes contain more than 5,000 chemicals that can have a negative impact on health and 70 other substances that can cause cancer.[2] The dangerous content of cigarette smoke includes nicotine, carbon monoxide, tar, nitric oxide, hydrogen cyanide, acrolein, benzo(a)pyrene, and N-nitrosamine.[3]

The Ministry of Health defines an active smoker as someone who consumes cigarettes regularly, no matter how small, even just one cigarette a day. Someone who just tries it and does not regularly consume cigarettes can also be called an active smoker.[4] Someone who smokes actively can be categorized based on the degree of smoking. One can classify an active smoker according to their level of smoking. According to one of them, active smokers can be categorized as light, moderate, or heavy users based on the Brinkman Index. This classification considers the quantity of cigarettes smoked daily as well as the years of smoking.[3]

The World Health Organization (WHO) reported that in 2020 there were around 991 million smokers aged ≥ 15 in the world. In the same year, in Indonesia, there were around 33.5% active smokers. Data from the Ministry of Health in 2022 stated an increase in the number of smokers in Indonesia by around 8.8 million people. Initially, around 60.3 million (2011) to around 69.1 million (2021). Badan Pusat Statistik (BPS) reports that there are 24.44% of smokers among residents aged ≥ 15 years in Daerah Khusus Jakarta (DKJ) on average consume 69.89 cigarettes every week

Every year around 225,700 people die from smoking or various other diseases related to tobacco consumption.[5-8]

Various bad effects can occur in active smokers, such as chronic obstructive pulmonary disease, atherosclerosis, and increased hemoglobin levels. Hemoglobin (Hb) is a protein in erythrocytes that carries oxygen from the lungs to all tissues. This protein is a globulin tetramer consisting of two subunits.[9,10] Each subunit has a polypeptide chain and also a prosthetic heme group of iron protoporphyrin IX. The heme group is linked to the polypeptide amino acid residues 141 (α) and 146 (β).[11]

In research conducted by Lakshmi et al., the results showed that hemoglobin levels were significantly higher in those who smoked more than 10 cigarettes every day.[12,13] The increase in hemoglobin levels due to smoking was influenced by exposure to one of the ingredients contained in cigarette smoke, namely carbon monoxide. Carbon monoxide will combine with Hb to form HbCo. Carboxyhemoglobin is an inactive form of hemoglobin so it cannot distribute oxygen to tissues. Carbon monoxide's stronger affinity for binding to hemoglobin results in easier formation of carboxyhemoglobin. It is estimated that the affinity of Hb and CO is 200 times stronger than the affinity between Hb and O_2.[14,15] The strong affinity of CO in binding Hb results in high carboxyhemoglobin so oxygen levels will decrease. The resulting decrease in oxygen levels will stimulate peripheral hypoxia. One of the body's compensatory mechanisms due to peripheral hypoxia is to maintain oxygen transport by increasing hemoglobin production.[12,16]

In research conducted in 2017 by Malenica et al., results showed that hemoglobin levels were significantly higher in smokers. This increase in smoking is associated with a greater risk of suffering from polycythemia vera.[12] This is different from Amelia's research in 2016 which stated that there was no relationship between the degree of smoking based on the Brinkman Index and hemoglobin levels. This research is supported by Sayekti's research in 2020 which stated that there was no effect of smoking on hemoglobin levels.[17,18] In the research carried out by Septiani in 2022, it was found that the more often and longer a person smokes, the lower their hemoglobin levels will be.[19]

This research will be carried out on residents of Tarumanagara University because the prevalence of smoking is still high among security officers at Tarumanagara University. In research conducted in 2019 by Kurniawan, there were at least 79 Tarumanagara University security officers who smoked out of 97 total samples obtained (81.4%).[20] Based on the background description explained, the author is interested and wants to research cleaning services, technicians, parking attendants, and security regarding the effect of smoking on hemoglobin levels in Tarumanagara University residents.

2. Methods

This research is an analytical research method with a cross-sectional approach and statistical tests were carried out using chi-square with sample collection using purposive sampling from Tarumanagara University residents including security officers, cleaners, parking attendants, and technicians who meet the predetermined inclusion and exclusion criteria. The inclusion criteria for this study were that respondents were aged between 18 and 60 years and were active smokers. Exclusion criteria include respondents with chronic diseases, such as AIDS, chronic kidney or liver disease, being infected with worms, taking ARV, blood-boosting tablets, or blood thinners. The research was carried out from December 2023 to February 2024 with a sample size of 184 respondents.

Measurement of hemoglobin levels will be carried out using the Point of Care Testing (POCT) method which can be done outside the laboratory. Hemoglobin examination will be carried out using test strips and also a digital hemoglobinometer with Fora 6 plus brand. Because only a small blood sample is needed, hemoglobin examination with POCT can generally use capillary blood, so that the examination can be carried

out easily and quickly.[21,22]

In research by Widianto et al., they stated that there were no significant differences in hemoglobin levels in venous and capillary blood samples. This is also supported by research by Puspitasari et al., who said that there was no statistically significant difference between the average results of examining hemoglobin levels using the capillary blood POCT method and the venous blood cyanmethemoglobin method. This is because veins and capillaries are in one interconnected blood circulation cycle, so both can be used as samples for hemoglobin examination.[22-24]

The results of hemoglobin levels use grams per deciliter (g/dl). The results of the classification of hemoglobin examination in men are 1) normal if the hemoglobin level is between 14 g/dl to 18 g/dl; 2) hemoglobin levels are considered low if < 14 g/dl and high if > 18 g/dl. Meanwhile, the classification results for women are 1) normal if the hemoglobin level is between 12 g/dl to 16 g/dl; 2) hemoglobin levels are considered low if < 12 g/dl and high if > 16 g/dl.[25]

The degree of smoking will be classified based on the Brinkman Index which is assessed by the number of cigarettes consumed each day multiplied by the number of years a person has smoked in their lifetime. The results of the multiplication will be made into points and classified into 1) light smoker if 0 to 199 points; 2) moderate smoker if 200 to 599 points; and 3) heavy smoker if the multiplication result is > 600 points.[3]

3. Results and Discussion

In this research, there were 184 respondents from Tarumanagara University, consisting of 173 respondents (94%) male and 11 respondents (6%) female. Most of the respondents to this study were male and this resembles the results of research conducted by Salsabila (2022) which stated that 95% of respondents who were active smokers were male. The reason men smoke more is because it is considered proof of masculinity in society.[25] This is also supported by a survey conducted by WHO in Indonesia in 2021 which stated that 65.5% of active smokers were men.[6]

The results of this study show the degree of smoking of respondents based on the Brinkman Index, 136 respondents (73.9%) are classified as light smokers, 45 respondents (24.5%) are moderate smokers, and 3 respondents (1.6%) are heavy smokers. This research is in accordance with research by Amelia (2016) which analyzed the relationship between the degree of smoking based on the Brinkman Index and hemoglobin levels in the Padang branch of the Indonesian Red Cross which obtained the highest number of light smokers and the lowest number of heavy smokers, namely 27 respondents (41.5%) were light smokers, 21 respondents (32.2%) were moderate smokers, and 17 respondents (26.2%) were heavy smokers. This result is influenced by the Brinkman Index which takes into account the average number of cigarettes consumed each day and the length of time the respondent has smoked in years, so that the varying ages of the respondents also influence the results of the distribution of the degree of smoking among respondents.[20]

In this study, the results of hemoglobin levels showed that 93 respondents (50.5%) had low hemoglobin levels, 90 respondents (48.9%) were normal and 1 respondent (0.5%) had high hemoglobin levels. These results are quite different from the results of research conducted by Mariani (2018) which found that 21 respondents (29.6%) had low hemoglobin levels, then 13 respondents (18.3%) had normal hemoglobin levels, and 37 respondents (52.1%) had normal hemoglobin levels. high.[26] The average hemoglobin level in male and female respondents will be lower in someone who has a heavier degree of smoking based on the Brinkman Index. In contrast to the results obtained in Amelia's (2016) research, the average hemoglobin level will increase in respondents whose smoking level is heavier.[18] The differences that occur can be influenced by various factors that can make differences in hemoglobin levels in respondents, including gender, age range, nutritional intake, medication, altitude in the area where they live, and also lifestyle.[27]

Table 1. Characteristics of research results.

Parameter	N (%)	Mean (SD)	Med (Min-Max)
Age		31.40 (9.14)	28.50 (19 – 60)
Gender			
Men	173 (94%)		
Women	11 (6%)		
Profession			
Security	80 (43.5%)		
Cleaning service	77 (41.8%)		
Parking attendants	22 (12%)		
Technician	5 (2.7%)		
Number of cigarettes/day		9.08 (7.77)	10 (0 – 60)
Duration of smoking (years)		12.80 (9.67)	12 (0 – 44)
Degree of smoking			
Light smoker	136 (73.9%)		
Moderate smoker	45 (24.5%)		
Heavy smoker	3 (1.6%)		
Hemoglobin level		13.82 (2.15)	13.9 (8.1 – 19.3)
Low	93 (50.5%)		
Normal	90 (48.9%)		
High	1 (0.5%)		

Table 2. Correlation of hemoglobin levels with degree of smoking.

Degree of smoking	Hemoglobin levels						P-value
	Low		Normal		High		
	n	%	n	%	n	%	
Light	56	41.2%	79	58.1%	1	0.7%	0.001
Moderate	35	77.8%	10	22.2%	0	0%	
Heavy	2	66.7%	1	33.3%	0	0%	

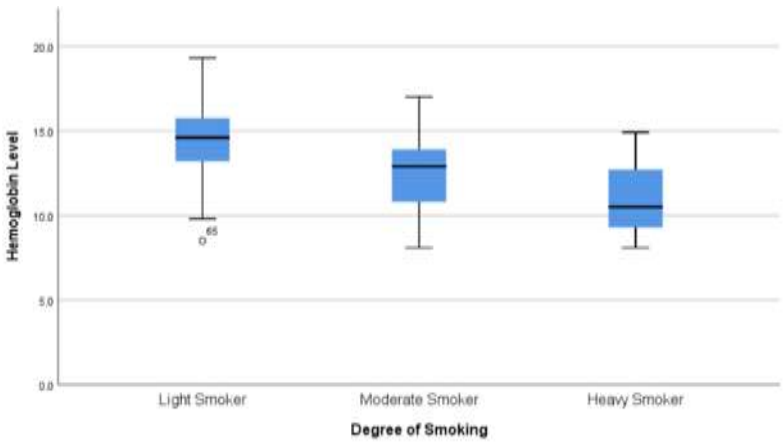

Figure 1. Boxplot of hemoglobin level by the degree of smoking.

In this study, the results showed that there was a statistically significant influence between the degree of smoking and hemoglobin levels with a p-value of 0.001. These results are supported by research by Septiani (2022) which states that there is a relationship between the duration and frequency of smoking and hemoglobin levels in active smokers in Palembang City.[19] However, this is different from the results of research by Amelia (2016) which obtained a p-value of 0.065, which means there is no relationship between the degree of smoking and hemoglobin levels.[18]

Carbon monoxide in cigarette smoke will inhibit the work of hemoglobin to bind oxygen so that less oxygen can be circulated to the tissues. The more cigarettes consumed and the longer a person smokes, the more oxygen transport will be disrupted, which will result in tissue hypoxia. In this situation, the body will respond by increasing erythropoietin production to increase erythrocyte production, so that hemoglobin levels in the body will increase in smokers.[15,16] However, in this study, the results showed that the majority of respondents who were light smokers (58.1%) had normal hemoglobin levels, while 77.8% of respondents who were moderate smokers and 66.7% of respondents who were heavy smokers had relatively low hemoglobin levels.

This shows that there is no increase in hemoglobin levels in moderate and heavy smokers, where the body should compensate for the decrease in oxygen transport by increasing erythrocyte production. The differences that occur can be caused by many factors that can influence the hemoglobin contained in erythrocytes, including gender, age, nutritional intake, medications consumed, altitude in the area of residence, and also lifestyle, which cannot be assessed in this study. This result is similar to research by Septiani (2022) which found that the more cigarettes consumed each day and the longer someone smokes, the lower their hemoglobin levels will be.[19]

Apart from the various factors that can influence hemoglobin levels, the decrease in hemoglobin levels in active smokers is believed to be related to a decrease in the body's ability to absorb iron. A case study conducted by Vivek, et al (2023) states that smoking has a strong relationship with iron deficiency anemia and the risk will be greater depending on the duration.[28] This process occurs due to reduced levels of vitamin C in the smoker's body as a result of the cigarettes consumed or the diet which is proven to be unhealthy in the majority of smokers. Fatima's research (2022) states that smokers consume less vitamin C, fiber, beta carotene, and vitamin E when compared to someone who is not a smoker [29-30]

Vitamin C or ascorbic acid is a water-soluble vitamin that functions as an antioxidant, increases endurance, and also increases iron absorption in the body. Antioxidants are molecules that are able to donate electrons to free radicals without losing their molecular integrity. As an antioxidant, the body will use vitamin C to slow down the destructive impact of various free radicals in cigarettes, which can accelerate cellular damage due to oxidative stress. The risk of oxidative stress will increase in someone who consumes cigarettes because the various contents of cigarette smoke, such as hydrogen peroxide, superoxide, and peroxynitrite, can increase the number of free radicals in the body. The large number of free radicals contained in the body will cause more antioxidants to be used, thus triggering an imbalance of free radicals and antioxidants in the body. Therefore, the level of vitamin C in a smoker's body will be lower and the ability to absorb iron will decrease, resulting in a decrease in hemoglobin levels in someone who consumes cigarettes.[30-33]

4. Conclusion

Based on the results of the analysis, it was found that there was a statistically significant influence between the degree of smoking and hemoglobin levels with p-value = 0.001. So one way to reduce the risk of health problems including problems with oxygen transportation is to reduce the amount of consumption and smoking.

5. References

1. Directorate General of Prevention and Control of Non-communicable Diseases of the Ministry of Health. What is a cigarette?. 2018.
2. Cancer Research UK. What's in a cigarette?. 2023.
3. Nusa GB, Widyastiti NS. Differences in neutrophil lymphocyte ratio in non-smokers, light smokers and heavy moderate smokers (Analytical Observational Study on Diponegoro University Students) (Doctoral dissertation, Diponegoro University).
4. Directorate General of Prevention and Control of Non-communicable Diseases of the Ministry of Health. What is Active Smoker?. 2019.
5. World Health Organization. Global Adult Tobacco Survey: Indonesia Report 2021. 2021.
6. World Health Organization. Statement: World No Tobacco Day 2020. 2020
7. Central Statistics Agency. Percentage of Smoking in the Population ≥ 15 Years by Province (Percent), 2020-2022. 2021.
8. Central Statistics Agency. Percentage of Population 5 Years and Above Who Smoke in the Past Month by Regency/City and Number of Cigarettes Smoked per Week, 2021. 2021.
9. Institute for Quality and Efficiency in Health Care (IQWiG). What does blood do? [Internet]. InformedHealth.org- NCBI Bookshelf. 2019.
10. Ahmed MH, Ghatge MS, Safo MK. Hemoglobin: structure, function, and allostery. Vertebrate and invertebrate respiratory proteins, lipoproteins, and other body fluid proteins. 2020: 345-82.
11. Marengo-Rowe AJ. Structure-function relations of human hemoglobins. Baylor University Medical Center Proceedings. 2006; 19(3): 239-45.
12. Malenica M, Prnjavorac B, Bego T, Dujic T, Semiz S, Skrbo S, et al. Effect of cigarette smoking on hematological parameters in a healthy population. Med Arch. 2017; 71(2): 132.
13. Elisia I, Lam V, Cho B, Hay M, Li MY, Yeung M, et al. The effect of smoking on chronic inflammation, immune function, and blood cell composition. Scientific Reports. 2020; 10(1): 19480.
14. Permatasari VS. The effect of active smokers and passive smokers on hemoglobin levels (Study in Candi Mulyo Village, Jombang District) (Doctoral dissertation, STIKES Insan Cendekia Medika Jombang).
15. Papathanasiou G, Mamali A, Papafloratos S, Zerva E. Effects of smoking on cardiovascular function: the role of nicotine and carbon monoxide. Health Sci J. 2014; 8(2): 274.
16. Pedersen KM, Çolak Y, Ellervik C, Hasselbalch HC, Bojesen SE, Nordestgaard BG. Smoking and increased white and red blood cells: a Mendelian randomization approach in the Copenhagen general population study. Arteriosclerosis, thrombosis, and vascular biology. 2019; 39(5): 965-77.
17. Sayekti S. The Effect of Smoking on Hemoglobin Levels (Study in Candi Mulyo Village, Jombang District). Insan Cendekia J. 2020; 7(2).
18. Amelia R, Nasrul E, Basyar M. The relationship between smoking degree based on the Brinkman Index and hemoglobin levels. Andalas Health J. 2016; 5(3).
19. Septiani R. The relationship between smoking duration and smoking frequency with hemoglobin (Hb) levels in active smokers. Babul Ilmi J Ilmiah Multi Sci Kes. 2022; 14(1).
20. Kurniawan J. Correlation between smoking and hypertension in security officers of Universitas Tarumanagara. 2019
21. Nidianti E, Nugraha G, Aulia IA, Syadzila SK, Suciati SS, Utami ND. Hemoglobin level examination with POCT (Point of Care Testing) method as early detection of anemia disease for the Community of Sumbersono Village, Mojokerto. J Sury Masy. 2019; 2(1): 29-34.

22. Widianto R, Purbayanti D, Ardina R. Differences in hemoglobin test results with point of care testing (POCT) in blood samples veins and capillaries. Borneo J Med Labor Technol. 2021; 4(1): 267-71.
23. Puspitasari P, Aliviameita A, Rinata E, Yasmin RA, Saidah SN. Differences in hemoglobin test results between the point of care testing method and the cyanmethemoglobin method in pregnant women. J Health Anal. 2020; 9(1): 24-8.
24. Keohane EM, Otto CN, Walenga JM. Rodak's Hematology - E-Book: Clinical Principles and Applications. Elsevier Health Sciences. 2019.
25. Salsabila, N, Indraswari, N, Sujatmiko, B. An overview of smoking habits in Indonesia based on the Indonesia Family Life Survey 5 (IFLS 5). Indones J Health Econ. 2022; 7: 13.
26. Mariani KR, Kartini KThe degree of smoking is related to hemoglobin levels in men aged 30-40 years. J Biomed Health. 2018.
27. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. World Health Organization. 2011.
28. Vivek A, Kaushik RM, Kaushik R. Tobacco smoking-related risk for iron deficiency anemia: a case-control study. J Addict Dis. 2023; 41(2): 128-36.
29. Fatima M, Khan AS. Relationship between Smoking and Diet. Quest J Manage Soc Sci. 2022; 10: 225–8.
30. Smoking and Vitamin C: Clarifying the concerns. [https://www.sun.ac.za/english/faculty/healthsciences/nicus/Documents/Files/Files/Fact_sheets/Vit%20C%20and%20Smoking.pdf (Last accessed 20 February 2024).
31. Fitria F, Triandhini RINK, Mangimbulude J, Karwur F. Smoking and DNA oxidation. Medical Science: J Med Health. 2013; 5: 113.
32. National Institutes of Health National Center for Complementary and Integrative Health. Antioxidant Supplements: What You Need To Know. 2023.
33. Sma W, Alvi A. Correlation between anemia and smoking: study of patients visiting different outpatient departments of Integral Institute of Medical Science and Research, Lucknow. Natl J Physiol Pharm Pharmacol. 2019; 1.