

Smoking habits and hemoglobin levels: Implications for donor screening among male blood donors

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Abstract

The selection of donors based on smoking habits is an important process to ensure the availability of safe, high-quality blood. This study aims to analyze the correlation between smoking habits and blood hemoglobin levels in men at the Indonesian Red Cross Blood Transfusion Unit in Balikpapan. An analytical observational study with a cross-sectional design was conducted involving 99 male donors who were purposively selected based on their smoking intensity. Hemoglobin levels were measured using a standard hematology analyzer, while smoking habits were evaluated through structured interviews. Data were analyzed using Pearson's correlation test to evaluate the relationship between smoking categories and hemoglobin levels. The results showed a significant positive correlation, with higher smoking intensity associated with increased hemoglobin concentration. These findings confirm the physiological mechanism of compensatory erythropoiesis in smokers and highlight the importance of considering lifestyle factors during donor selection. This study provides insight into the hematological effects of smoking in clinical practice.

1. Introduction

Blood donation is the voluntary blood collection from an individual, which is then stored in a blood bank for transfusion purposes (Lesmana, 2016). This action is crucial in the healthcare system due to the increasing demand for blood each year, necessitating a rigorous donor selection process to ensure the availability of safe and high-quality blood (WHO, 2020). Based on Minister of Health Regulation No. 91 of 2015, prospective donors can only donate blood after passing a health screening, which includes anamnesis and physical examination, including hemoglobin (Hb) levels. As the main oxygen-carrying protein, Hb is an important indicator in determining donor eligibility. Adequate Hb levels not only protect the health of donors but also ensure the quality of the blood to be transfused (Kim & Cho, 2020). Low Hb levels can be one of the main reasons for postponing donations, which has the potential to reduce the availability of blood supplies (Roubinian et al., 2019).

Normal hemoglobin levels range from 12.5–17 g/dL and are one of the important parameters in determining the quality of blood to be transfused. Hemoglobin binds and transports oxygen, ensuring the quality of blood given to recipients (Ministry of Health, 2015). Hemoglobin levels are influenced by biological and lifestyle-related factors, such as age, gender, diet, physical activity, and certain medical conditions such as leukemia, thalassemia, and tuberculosis (Chien et al., 2018; Abdullah et al., 2020). One of the most influential lifestyle factors is smoking, as cigarette smoke contains carbon monoxide (CO), which binds strongly to hemoglobin and reduces oxygen-carrying capacity. Chronic hypoxia due to CO

exposure triggers an increase in erythropoietin production, stimulating erythropoiesis, thereby increasing hemoglobin levels (Vardavas et al., 2020). Smoking harms health and affects hemoglobin levels (Astuti, Subekti, & Wijaya, 2022).

Smoking is a global problem, especially in developing countries. The prevalence of smoking in Indonesia is high, particularly among men, reaching 29.3% and tending to increase from adolescence to adulthood (Indonesian Ministry of Health, 2021). The average cigarette consumption of active smokers can even reach one pack per day, which indicates a high intensity of exposure to harmful substances. Smoking increases the risk of chronic diseases and affects hematological parameters such as hemoglobin levels, which are related to blood donor eligibility (Sari et al., 2021).

Several studies have reported increased hemoglobin levels in smokers (Masood et al., 2019; Ahmed et al., 2022), while other studies have found no significant association (Alotaibi et al., 2021). Astuti and Artini (2019) stated that there was no significant relationship between smoking status and hemoglobin levels in donors, while Septiani (2022) reported a significant relationship between the duration and frequency of smoking and hemoglobin levels in active smokers. These differences in findings may be due to variations in research design, measurement methods, and the characteristics of the population studied. Previous studies have focused on the general population or clinical patients rather than blood donor groups, emphasizing the importance of hemoglobin as a key parameter in donor selection (Farhan et al., 2019).

Inconsistent results regarding the relationship between smoking habits and hemoglobin levels must be re-examined to obtain information that ensures donor eligibility and guarantees transfusion safety. Additionally, empirical evidence in the blood donor population is still limited. Therefore, this study aims to analyze the correlation between smoking habits and hemoglobin levels in male blood donors. The findings of this study can provide evidence of the hematological impact of smoking habits and support public health strategies to ensure the quality and safety of the blood supply.

2. Method

2.1 Research Design and Participants

This study employed an analytical observational design with a cross-sectional approach. The research was conducted at Balikpapan's Blood Transfusion Unit of the Indonesian Red Cross (UTD PMI). Ninety-nine male blood donors were recruited as participants using a purposive sampling technique (Subhaktiyasa, 2024b). Inclusion criteria consisted of male donors eligible for blood donation based on institutional standards and provided informed consent to participate. Donors with a history of chronic illness, hematological disorders, or conditions that could influence hemoglobin levels were excluded. Participants were categorized into three groups based on their smoking habits: light smokers (≤ 10 cigarettes/day), moderate smokers (>10 – 20 cigarettes/day), and heavy smokers (>20 cigarettes/day).

2.2 Instruments and Data Collection

Hemoglobin levels were measured using a standardized hematology analyzer at the UTD PMI Balikpapan laboratory. Smoking habits were assessed through structured interviews, in which participants reported the average number of cigarettes smoked daily (Subhaktiyasa, 2024a). Data were collected directly during the donor screening by trained medical laboratory personnel.

2.3 Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to summarize participant characteristics and mean hemoglobin levels across smoking categories (Subhaktiyasaa et al., 2025). The Pearson correlation test assessed the relationship between smoking habits and hemoglobin levels. A p-value < 0.05 was considered statistically significant.

2.4 Ethical Considerations

Ethical approval was obtained from the institutional ethics committee (approval number: 473/E1.STIKESWIKA/EC/IV/2025). Before data collection, all participants were provided with information regarding the study's purpose and procedures, and written informed consent was obtained. Confidentiality and anonymity were maintained throughout the research process.

3. Results and Discussion

3.1 Results

The study included 99 male blood donors categorized according to smoking habits. The mean haemoglobin levels for each group are presented in Table 1.

Table 1. Mean hemoglobin levels of blood donors according to smoking habits

Category	Mean Hb (g/dL)	SD	Range (g/dL)
Light (≤ 10 cigarettes/day)	16.52	0.61	48.0
Moderate (11–20 cigarettes/day)	16.81	0.55	20.0
Heavy (> 20 cigarettes/day)	17.23	0.64	32.0

Table 1 shows that the mean hemoglobin levels of light, moderate, and heavy smokers were 16.52 g/dL, 16.81 g/dL, and 17.23 g/dL, respectively. These results indicate an increase in hemoglobin concentration, with heavy smokers demonstrating the highest values. Further analysis using Pearson's correlation test examined the relationship between smoking habits and hemoglobin levels among male blood donors at the Balikpapan PMI Blood Transfusion Unit. The results demonstrate a correlation coefficient of $r = 0.393$ with a p-value of 0.000, and a statistically significant positive relationship between smoking habits and hemoglobin levels. These results confirm that there is a tendency for higher smoking intensity to be associated with higher hemoglobin levels.

3.2 Discussion

This study demonstrates a significant positive correlation between smoking habits and hemoglobin levels in male blood donors at the Balikpapan PMI Blood Transfusion Unit. These findings confirm that the higher the intensity of smoking, the higher the hemoglobin levels tend to be. This relationship explains the role of carbon monoxide (CO) in cigarette smoke. CO has a strong affinity for hemoglobin, thereby reducing its oxygen-binding capacity. Chronic hypoxia due to CO exposure stimulates erythropoietin production, increasing erythropoiesis and leading to elevated hemoglobin levels (Vardavas et al., 2020; Xu et al., 2023). Previous studies have also shown that long-term exposure to cigarette smoke increases oxidative stress and accelerates eryptosis or red blood cell death, thereby altering hematological balance (Schmitt et al., 2024; Stefanoni et al., 2020). Moreover, smoking can trigger inflammation and changes in erythrocyte indices, which have been consistently reported in various studies (Foy & Jacobs, 2020; Çiftçiler, 2019; Acik et al., 2020).

This study's results are consistent with several studies reporting that smokers tend to have higher hemoglobin levels than non-smokers and light smokers (Chien et al., 2018; Ahmed et al., 2022; Masood et al., 2019). Similar findings have also been reported in male populations in Korea (Kim & Cho, 2020), workers in Taiwan (Hsieh et al., 2021), as well as populations in Iraq (Al-Hadrawi et al., 2024), Bangladesh (Al Towhid et al., 2023), and the Middle East (Moalif et al., 2025). However, these results contradict the study by Alotaibi et al. (2021) on men in Saudi Arabia, which found no significant relationship between smoking and hemoglobin levels. Variations likely influence these differences in findings in study design, measurement methods, and the characteristics of the populations studied.

This study provides an important contribution as empirical evidence regarding donor eligibility and transfusion safety in Indonesia. The results of this study expand on previous findings regarding donor-recipient safety (DeSimone et al., 2020) and add to the literature on hematological changes due to smoking in various populations (Pedersen et al., 2019; Reddy et al., 2018; Mourouguesine Vimal & Nishanthi, 2019). These findings also reinforce the practical implication that increased hemoglobin levels in heavy smokers do not always reflect good health, but may mask other risks such as hyperviscosity that could potentially harm both donors and recipients (Wang, 2023). Furthermore, the development of alternative smoking methods such as electronic cigarettes and shisha has also been reported to cause hematological and inflammatory changes comparable to conventional cigarettes (Homoud et al., 2025; Manietta et al., 2025; Seo, 2022). Therefore, lifestyle factors, including smoking habits, are important to integrate into donor evaluation to ensure transfusion safety. Although the results show that smoking habits are associated with hemoglobin levels in blood donors, this study has several limitations. The relatively small sample size, limited to male donors at one institution, and the use of self-reported smoking habit data have the potential to introduce bias. Therefore, further research should involve a larger sample with a more diverse population,

including female donors, and use objective biomarkers to measure tobacco exposure (Schmitt et al., 2024; Homoud et al., 2025).

4. Conclusion

This study demonstrated a significant positive correlation between smoking habits and hemoglobin levels among male blood donors, with heavy smokers showing higher mean hemoglobin concentrations compared to light and moderate smokers. These findings provide empirical evidence of hematological adaptations to smoking, emphasizing that elevated hemoglobin should not be interpreted as an indicator of good health but rather as a compensatory response to chronic hypoxia that may carry long-term risks. The results have important implications for donor screening and the interpretation of hematological parameters in clinical and public health contexts, underscoring the need to integrate lifestyle factors such as smoking into blood safety protocols. However, the study's limitations, including the relatively small sample size, focus on male donors from a single institution, and reliance on self-reported smoking habits, may affect the generalizability of the findings. Future research should therefore involve larger and more diverse populations, incorporate objective measures of smoking exposure, and explore additional hematological outcomes to strengthen understanding of the broader health consequences of smoking.

Conflict of Interest

The authors declare no conflict of interest.

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