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The Role Of Air Pollution Exposure On Hemoglobin Levels In Public Fueling Station Officers

Zarathustra Ath. Thaariq Lustician, Liliawanti*, Dagradi Eric Mayo, Anindya Pramita

Fakultas Kedokteran, Universitas Hang Tuah, Surabaya, Indonesia

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Author correspondence:
Correspondence of the author:
Name: Liliawanti, dr., M.Biomed
Institution: Department of Biology, Faculty of Medicine, Hang Tuah University, Surabaya, Indonesia
Address: Jalan Gadung No. 1, West Complex of Dr. Ramelan Hospital Surabaya
Email: (Liliawanti@hangtuah.ac.id)

ABSTRACT

Air pollution is recognized as one of the risk factors that affects the hematological and immunological systems, particularly by decreasing hemoglobin levels or leading to the development of anemia. Hemoglobin functions as a transport medium to carry and distribute carbon dioxide and oxygen in the tissues, where it is part of red blood cells, also known as erythrocytes. Hemoglobin is categorized as low if it is below 13.5 g/dl in men, and 12 g/dl in women. The purpose of this study is to investigate the impact of air pollution exposure on the hemoglobin levels of public gas station employees. The method employed is a literature study that involves comparing journal articles that review relevant themes and summarizing previous literature related to these themes. The population subjects used contain articles that explain the effect of air pollution exposure on hemoglobin levels in gas station workers. The results of the study, based on 10 articles, showed that most studies indicate continuous exposure to air pollution over a long period can interfere with hemoglobin synthesis, as evidenced by the decrease in hemoglobin levels among public gas station workers. This study concludes that air pollution exposure has an Influence on the hemoglobin levels of gas station officers.

Introduction

Air pollution is a mixture of particulate matter (PM), gases (ranging in size from a few nanometers to micrometers), and pollutant gases that can exist in both the particulate and gas phases. Particulate matter can be PM_{10}coarse (average aerodynamic diameter 10–2.5 μm) or OK PM 2.5 (0.1–2.5 μm) or ultrafine (<0.1 μm) (1). Air pollution due to PM10 is mainly caused by industrial, mining, and construction dust, while pollution due to PM2.5 comes from the burning of fossil fuels and biomass, as well as the burning of stubble after the rice harvest (2). Approximately 80% of air pollution in Indonesia, particularly in urban areas, is attributed to the transportation industry, where the primary sources of these pollutants include CO, Pb, NO_2, SO_2, carbon, and other particulate matter (3).

Air pollution is known to cause various health problems for the human body, including impacts on the respiratory, cardiovascular, dermatological, ophthalmological, reproductive, neuropsychiatric, hematological, and immunological systems. Long-term exposure to molecular and cellular factors can trigger various types of cancer. Even small amounts of exposure can affect the body's physiological condition, especially in vulnerable groups (4).

Air pollution is a risk factor that contributes to decreased hemoglobin levels or the development of anemia, particularly when associated with the hematological and immunological systems. Air pollution impacts not only children, pregnant women, and the elderly, but recent research suggests it also affects the general population.

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Hemoglobin functions as a transport medium, transporting and distributing carbon dioxide and oxygen within tissues. Hemoglobin is part of red blood cells, or erythrocytes (4). Hemoglobin is considered low if it is below 13.5 g/dl in men and below 12 g/dl in women. A person cannot get enough oxygen if they lack hemoglobin; this condition is known as anemia (5).

Anemia is a reflection of pathophysiological changes that can be examined through anamnesis, including complaints and a previous medical history, and can be further assessed through physical examination and laboratory tests. Symptoms that arise are usually feeling quickly tired, fatigue, reduced concentration, and drowsiness (6). Anemia is prevalent in various parts of the world, with a higher incidence in developing countries. Indonesia is an example of a developing country where people still do not fully understand and realize the importance of nutrition. Consequently, the prevalence of anemia in Indonesia is relatively high, particularly iron deficiency anemia (5). Specifically, it has been reported that anemia can lead to a higher risk of poor clinical outcomes, including impaired cognitive function, cardiovascular disease, and death (7).

Air pollution exposure was significantly associated with increased prevalence of anemia and decreased hemoglobin levels. The interquartile range (IQR, 3.9 $\mu g/m^3$) in an average of one year is positively related to the prevalence of anemia (*prevalence ratio*, or PR, 1.33; 95% CI: 1.23, 1.45) and an average decrease in hemoglobin of 0.81 g/dL ($p < 0.001$) (8). The prevalence of anemia is estimated to be around 2 billion, or more than 30% of the global population, experiencing anemia. Indonesia has a prevalence of anemia that is still relatively high at around 21.7% where sufferers in the 5-14 year age range amounted to 26.4% and those aged 15-24 years amounted to 57% (6). The prevalence in East Java is around 5.8% (10), in Central Java, 57.7% (19), among adolescent girls in West Java, 51.7% (12), and in North Sumatra, 15-39% (13). The WHO categorizes the prevalence of anemia as follows: severe if ≥ 40%, moderate between 20% and 39.9%, mild between 5% and 19.9%, and normal if ≤ 4.9% (10).

Gas stations are places that can potentially have relatively high exposure to air pollution, which can be observed from the total number of vehicles entering and leaving the station when purchasing fossil fuels. One of the groups at risk of experiencing the effects of air pollution is gas station attendants (2). Gas station operators, while providing services, are likely to be exposed to pollutants daily. High-dose exposure over a prolonged period can have a significant impact on the health of gas station operators (14).

Based on the previous explanation, the author wanted to understand the role of air pollution exposure on the hemoglobin levels of gas station attendants. The incidence of anemia is relatively high, with exposure to air pollution from motor vehicle exhaust being a significant contributing factor. These factors need to be identified and prevented to reduce the incidence. At the very least, we can minimize, if not eliminate, the incidence of anemia.

Methodology

This study employs a descriptive research design, aiming to investigate without proposing hypotheses. The research focuses on describing and presenting a summary of actual situations and phenomena in society. The method employed is a literature review, which compares journal articles covering relevant themes and summarizes the existing literature related to those themes.

The population used consisted of articles explaining the role of air pollution exposure on hemoglobin levels in gas station attendants. For this study, the sample consisted of every journal article that met the inclusion criteria and did not meet the exclusion criteria, with a minimum sample size of ten journal articles. The sample

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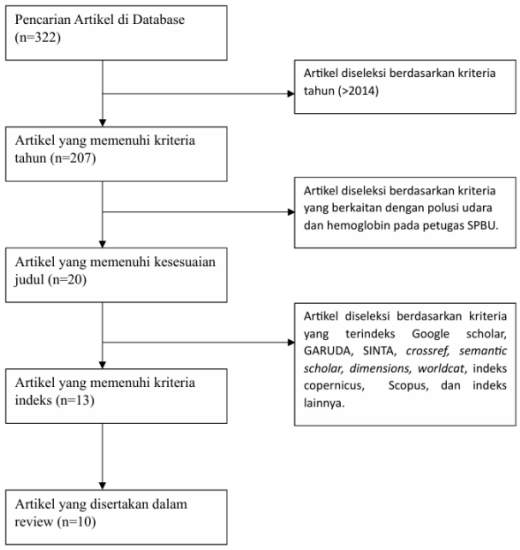
was collected from national or international journal articles using keywords such as air pollution, hemoglobin, and *gas station officer*.

The procedure for data collection begins with selecting a topic related to air pollution and its impact on the hemoglobin levels of gas station attendants. Then, questions are determined based on the literature review topic, which will be presented in the form of a research table. Determining the scope of the review and selecting the database to be used for the search. Conducting a search and finding relevant literature using keywords as stated in the sampling technique, and carefully reviewing the abstract and conclusions. Analyze or review the journal articles that have been collected based on the search results and those that have been selected, such as looking for similarities, looking for differences, providing views, and comparing journal articles.

The author processes the collected data using the following steps: Reading the research results from each national or international journal article from which data has been collected. Conducting a merger and evaluation by classifying journal articles according to inclusion criteria and those that do not meet exclusion criteria. Compiling the results and conclusions of several journal articles in the form of a research table consisting of the author's name, journal title, journal period, research results, research conclusions, and journal article database.

Results and Discussion

The data search in this study utilized the Google Scholar database, Open Journal System, Semantic Scholar GARUDA, Crossref, Scopus, SINTA, Dimensions, WorldCat, and the Copernicus index, with search keywords including air pollution, hemoglobin, and gas station officer. The search yielded several articles. These articles were sorted by year of publication, with publications from 2014 and above discussing the role of air pollution exposure on hemoglobin levels in gas station attendants, resulting in 10 articles.



(*Flowchart* Prisma)

Table of Included Articles

No	Judul	Penulis	Tahun
1	Gambaran kadar hemoglobin (HB) Petugas SPBU PT. Tabing Raya Kota Padang	Marisa, Yunda Wahyuni	2019
2	Gambaran Kadar Hemoglobin Pada Petugas SPBU	Devita T Manullang, Jon Farizal, Putra A Irawan	2022
3	Hubungan Lama Kerja >3 Tahun Terhadap Kadar Hemoglobin Pada Petugas SPBU Pangkalan Bun	Siska I Sari, Nur A Hidayah, Riky	2021

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4	Pengaruh Waktu Kerja Terhadap Kadar hemoglobin dan Jumlah Sel Daeah Merah Petugas Shift SPBU Jati Pariaman	Muhammad S Abeiasa	2020
5	Faktor Yang Berhubungan Dengan Kadar hemoglobin Pada Petugas SPBU di Kecamatan Jambi Selatan Kota Jambi	Rizki E Aprilian, Samsul Hilal, Novi Berliana	2023
6	Pemeriksaan Hemoglobin Pada Petugas SPBU di Daerah Glugur Rimbun Kabupaten Deli Serdang Tahun 2021	Radina YM Ginting, Puspta Wahyu	2023
7	Hubungan Kadar Timbal Dalam Darah Dengan Kadar Hemoglobin Pada Operator SPBU Gombel Semarang	Susiani, Mastuti W Lestari	2022
8	Studi Literatur Pengaruh Lama Kerja Terhadap, Kadar Hemoglobin, Pada Pekerja, Yang Terpapar, Asap Kendaraan Bermotor	Deiin D Indwek, Wiwik A, Risna Y Mumpuni	2022
9	Paparan Timbal (Pb) Terhadap Kadar Hemoglobin di Dalam Darah	Dhimas P Sinatra, Norma F Fahmi, Faisal Amir	2020
10	Analisis Pajanan Timbal Udara dan Timbal Dalam Darah Dengan Tekanan Darah dan Hemoglobin (Hb) Operator SPBU	Ayu R Nurfadillah, Irwan	2019

In several articles, such as articles 1, 3, 4, 5, 8, 9, 10, it is shown that there is an Influence between research variables. The review of several of these articles is generally in line with Theory (15) where air pollution is any substance in the environment that can harm humans, animals, plants or materials with one of the sources being transportation, especially motor vehicles which will later produce various impacts on health, an example in this case is low hemoglobin levels in the blood (13). Theory (16) also has similarities with the Theory discussed previously, that motor vehicle exhaust is the largest source of air pollution, where it contributes around 70% of the

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total percentage, then followed by industry with a range of 10 - 15%, then filled the rest by burning garbage, household smoke, forest fires and others (17).

Most articles mention that the pollutant affecting hemoglobin levels and often discussed is Pb, or lead, where the heme biosynthesis process can be inhibited by lead entering the body. Lead inhaled into the lungs is absorbed and binds to the blood, then distributed to all tissues and organs of the body. > 90% of absorbed lead binds to erythrocytes, and the main impact is disruption of heme biosynthesis and blood cell formation. (17), this is also in line with the Theory (7), which explains that air pollution contributes to disruption of iron homeostasis because it can cause cellular iron deficiency through activation of oxidant production and increased secretion of pro-inflammatory mediators. In addition, increased pro-inflammatory cytokines caused by exposure to air pollution can lead to a deficiency in erythropoietin secretion, resulting in anemia. Furthermore, exposure to air pollution increases the secretion of reactive oxygen species, leading to oxidative stress, which is also closely linked to anemia.

Lead (Pb) interferes with the activity of the ferrochelatase enzyme, a crucial step in the final stage of heme biosynthesis. Disruption of this enzyme inhibits the heme biosynthesis process, thus affecting hemoglobin synthesis. As a result, hemoglobin levels decrease, which can be an indicator of anemia. (17), the sentence above is also by the Theory of hemoglobin synthesis written by (Yostina Farid et al., 2023) where he explains that the final step of heme synthesis is the addition of Fe to protoporphyrin IX by ferrochelatase, producing heme molecules, if this enzyme is inhibited then automatically the heme synthesis process will not run properly.

The research results in article number 1 are influenced by risk factors such as increased physical activity, which can cause fatigue and a lack of rest while working, as well as inadequate fluid intake due to activities like exercise. In addition, lack of nutritional intake also plays a role in influencing the research (11). The research results in article number 3 are influenced by the length of service, where respondents with a length of service greater than 3 years tend to have abnormal Hb values. Sleeping late at night can also be a risk factor for decreasing hemoglobin levels. Sleeping after 11 or midnight can result in drowsiness while working, which may cause a decrease in hemoglobin levels because oxygen bound to hemoglobin is reduced (18).

The results of study number 4 showed a significant effect of night shift work on hemoglobin levels and red blood cell counts in gas station night shift workers. Sleeping less than 8 hours can increase the number of free radicals in the blood, which is related to liver function during sleep. The liver plays a crucial role in regulating various body systems, including the production of red blood cells. An increase in red blood cell count can also lead to a rise in the number of free radicals in the blood. *Free radicals and the decline in liver function. It is known that they can affect the balance of erythrocyte membrane function, which will later have an impact on reducing the affinity of erythrocytes for oxygen due to poor hemoglobin metabolism, thus disrupting oxygen transport throughout the body* (20).

The results of the study in article number 5 show a significant Influence of the use of personal protective equipment in the form of masks on the hemoglobin levels of gas station officers. Respondents who do not use PPE while working will allow benzene to enter the body easily, thereby affecting hemoglobin levels. Additionally, benzene and lead, which are commonly found in the work area, can also enter the body through inhalation (21). The results of the study in article number 8 indicate that the length of work has an Influence on the hemoglobin levels of gas station officers. Respondents who are exposed to air pollution from motor vehicles with a long working period

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will experience a decrease in hemoglobin levels in most of them (5).

The results of the study in article number 9 indicate a correlation between lead levels and hemoglobin levels in the blood, which can occur due to prolonged exposure, potentially leading to a decrease in hemoglobin levels and an increased risk of anemia. Lead absorbed by the body will bind to erythrocytes and then circulate to the blood, extracellular fluids, and several storage sites in soft tissues such as nerves, kidneys, liver, and mineral tissue, thus, Pb can be detected in the human body through soft tissues, blood, and mineral tissues such as bones, nails, teeth, hair (22). The results of the study in article number 10 show that there is an Influence of age on Hb levels and lead levels in the blood of gas station attendants. With increasing age, lead accumulation in body tissues tends to increase because the activity of biotransformase enzymes decreases, which impacts the ability of specific organs to reduce lead levels (14).

Conclusion

This study concludes that exposure to air pollution is associated with lower hemoglobin levels in gas station officers who work at least 8 hours a day and have a service length of more than 3 years.

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