Kesmas

Volume 19
Issue 5 *Special Issue 1, July*

Article 6

7-31-2024

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Recommended Citation

Yuniarti E , Exposto LA , Dewata I , et al. Health and Environmental Pollution: A Literature Review. *Kesmas*. 2024; 19(5): 38-45
DOI: 10.21109/kesmas.v19isp1.1102
Available at: https://scholarhub.ui.ac.id/kesmas/vol19/iss5/6

Yuniarti *et al. Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2024; 19 (Special Issue 1): 38-45
DOI: 10.21109/kesmas.v19isp1.1102

Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)

Health and Environmental Pollution: A Literature Review

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Abstract

This study aimed to review various studies focusing on pollution that could adversely affect health, including sources, types, and mitigation efforts. The data used were obtained through a search on the Scopus website using the keywords "Health" AND "Pollution" from 2016 to 2023. Using these two keywords, 72 titles and abstracts of papers were successfully found. The results of this literature review were then analyzed with the assistance of NVivo 12 Pro, which grouped the findings based on their impact on health, reasons for pollution, types of pollution, and preventive measures. It was identified that the most common disease was respiratory disorder. One of the leading causes was vehicle combustion, emitting carbon monoxide due to the incomplete combustion of fossil fuels, such as petroleum and natural gas. This study also revealed that the dominant focus of those studies was on air and water pollution. These studies also indicated that solutions to pollution-causing diseases generally include using renewable fuels, waste management, public health literacy, and adopting electric vehicles.

Keywords: combustion fossil fuels, environment, health, pollution, respiratory diseases

Introduction

Rapid global economic growth and technological advances have modernized human lives, but it has a long-lasting impact on ecology and environmental sustainability. Over the past few decades, the world has experienced increasing emissions of toxic gases, severe global warming, and ambient air pollution. Mass reliance on internal combustion engine (ICE) vehicles has rightly been criticized for increasing air pollution, endangering public health, and facilitating the use of fossil fuels, all of which threaten sustainable development.[1,2] Fossil fuels, such as petroleum and natural gas, remain the major energy sources that drive the economy and development worldwide. This has negative implications for public health and environmental pollution due to the intrinsic properties of the compounds in fossil fuels, especially petroleum, the most widely used fuel.[3] The primary product in the process of refining petroleum through fractional distillation is gasoline containing aliphatic hydrocarbon compounds, especially n-heptane and isooctane, a few aromatic compounds such as toluene, and very little contains several organic compounds containing nitrogen and sulfur elements originating from anaerobic decomposition of biomolecules, in particular, proteins under sediments during the petroleum formation process.[4]

Burning gasoline completely due to the abundance of oxygen (O_2) produces carbon dioxide (CO_2). The CO_2 can last in the atmosphere for 200 years, and increasingly thick deposits of carbon dioxide gas can cause a greenhouse effect because it can absorb and trap infrared wave heat from the sunlight, thus significantly increasing the earth's temperature, known as the global warming phenomenon. Climate change affects the quantity and quality of food produced, as well as its equitable distribution.[5] Several lower-middle-income countries, especially those that still have dense forests, gain "benefits" from CO_2 emissions through carbon compensation funds because they contribute to reducing CO_2 emissions.[6] However, when viewed from the perspective of the human development index, income in rich countries driven by transportation and industrialization produces enormous CO_2 emissions that have an impact on food security and human health, environmental damage, and carbon compensation received by low-income countries are

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Received: February 11, 2024
Accepted: July 15, 2024
Published: July 31, 2024

very small, which is disproportionate to the tremendous impact caused by CO_2 emissions.[5] An increase in gross domestic product per capita by 1% will decrease (inelastic) CO_2 emissions by 1.45%. In comparison, an increase in industrialization by 1% will increase CO_2 emissions (elastic) by 1.64% in the long term.[7] Deteriorating environmental quality, global warming, and climate change pose serious threats to future population, health, and international development.[7] Environmental pollution increasingly worsens its adverse impacts on human health.[8]

The increasing demand and use of diesel engines in various oil fields cause exhaust gas emissions, such as sulfur dioxide (SO_2), nitrogen oxide (NO_x), such as nitrogen monoxide (NO) and nitrogen dioxide (NO_2), and carbon monoxide (CO), causing severe environmental pollution and dangers such as respiratory problems.[9] Incomplete gasoline combustion due to limited oxygen gas produces carbon monoxide gas. CO gas can bind to hemoglobin 200 times stronger than O_2 gas, causing cells and body tissues to experience a lack of oxygen (hypoxia), leading to death.[10] Burning gasoline and diesel, which contain small amounts of organic compounds with a small amount of nitrogen in their composition, produces NO gas, which can carry out photochemical reactions, with the final result being the compound peroxyacetyl nitrate (PAN), which can cause eye irritation and respiratory problems.[11] Apart from that, NO_2 gas can also carry out a series of reactions, the final result of which is nitric acid (HNO3), which causes symptoms of acid rain. Acid rain can also be caused by sulfuric acid (H_2SO_4) through SO_2 pollution from burning gasoline and diesel.[11]

Global warming and air pollution due to non-renewable energy sources have long-term negative impacts on human health and the environment. Various solutions must be immediately made to ensure the survival of the next generations on earth. One method being intensively implemented is using eco-friendly renewable energy sources, such as solar energy or biodiesel, one of which is battery-powered electric vehicles. Therefore, they do not produce gas emissions that can pollute the air and damage the environment.[12] Preventive solutions to reducing pollution causing health and environmental problems can be provided through public health literacy. This can start from causes of pollution, household waste management, cultivating the behavior of throwing waste in its place, and greening movements through planting trees. Then, self-awareness emerges in each community member to be jointly responsible for environmental sustainability and a healthier and more prosperous quality of life.

Over the past decades, most researchers have paid much attention to ways to reduce environmental pollution in their regions. Therefore, this has culminated in several approaches and solution models being formulated, ranging from ordinary linear regression, multivariate regression, and Auto-Regressive Integrated Moving Average (ARIMA) to contemporary practices. The model environment was developed to achieve sustainable growth without destroying the environment. These environmental energy models can be classified as dynamic, static multivariate, univariate, or hybrid. Several researchers have investigated the development of energy environmental relations.[13] This study aimed to bibliometric analysis of various studies of pollution having a negative impact on public health and environmental damage, including sources of pollution, types of pollution, the impact of pollution on health and the environment, as well as various solutions offered to overcome pollution problems to create a better life and healthier and more sustainable environment.

Method

This study used secondary data from several studies examining various perspectives on pollution based on impacts on health and solutions that had been attempted to prevent these impacts. The secondary data was obtained through a search on the Scopus website with the keywords "Health" AND "Pollution" from 2016 to 2023 on November 3, 2023. The year range was selected for the phenomenon of extreme air pollution in Jakarta in 2023; in addition, a study stated that Jakarta was the most polluted city in the world.[14] Therefore, the authors are interested in exploring how to further study pollution as information for all parties who play an active role in preventing pollution. These two keywords obtained 72 titles and abstracts in English or Indonesian recorded in the Scopus database. As the primary source for this study, the review was carried out based on metadata information, and 36 pieces of literature were selected. The selection was made after looking at the entire content of the article and selecting based on the aim of this study. The object of this study is to know the various studies of pollution having a negative impact on public health and environmental damage.

In each group, a discussion was carried out, and a subdiscussion with the most literature was selected by linking the literature in that group with an NVivo label in the form of a "notepad," which had a code for the serial number of the literature and the year of publication. With the help of NVivo, the discussion of the results of this study became clearer in connecting each pollution category with health and the literature examining it.

Results and Discussion

Interpretation of the literature review results was mapped with the help of NVivo 12 Pro (v12.1.115-d3ea61) with groupings including impact on the health problem, prevention, reason, and types of pollution (Figure 1).

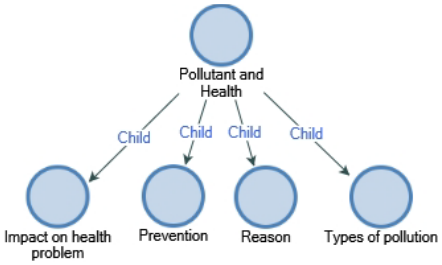
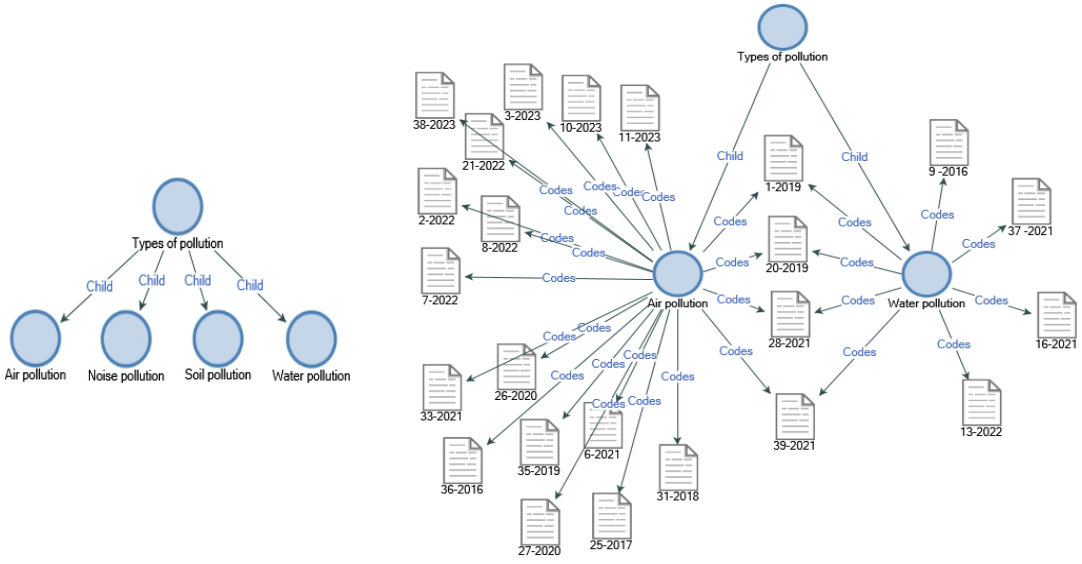


Figure 1. Interpretation of Pollution and Health Studies (Mapped with NVivo 12 Pro)

Based on Figure 1 above, there is a direct and strong correlation between pollutants resulting from various human activities and their negative impacts on human health and environmental damage. Burning fossil fuels is a major source of pollution which endangers health and causes environmental damage. The various types of pollution include land, water, and air pollution.

Types of Pollution



(a) **(b)**

Figure 2. (a) Types of Pollution Impacting Human Health, (b) The Most Common Pollution Occurs and Impacting Human Health

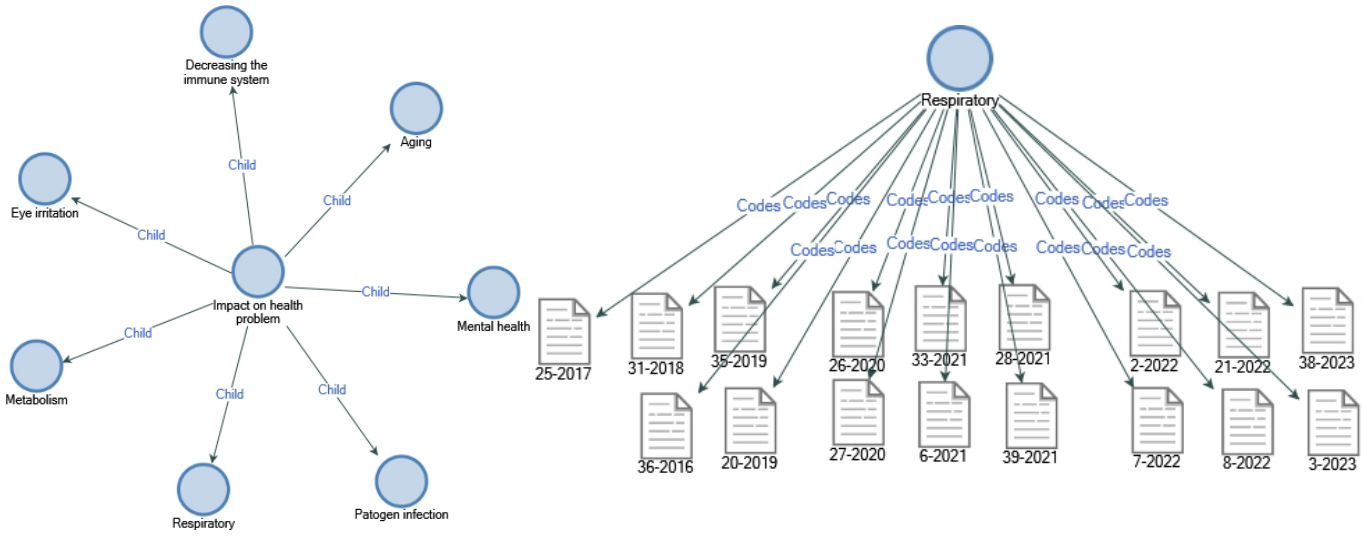
In this study, various information was obtained about the types of pollution that could potentially be dangerous to human health, including air pollution, land pollution, water, and sound or noise. Various studies showed that the most dominant research focuses on air and water pollution (Figure 2). Figure 2 shows 20 studies on air pollution and 8 on water pollution. Studies on air pollution have been the focus of research since 2016 and will increase in number in 2023. These findings concluded that health problems from air pollution have not been completely resolved; in fact, they continue to grow. One of the major causes of air pollution is the rapid increase in the global population and demand for the energy sector. In the end, the use of fossil fuels continues to grow, even carelessly, resulting in greenhouse gases, air pollution, and global warming, which causes ecological imbalance and health risks.[15]

One of the potential causes of soil pollution was the occurrence of explosions at landfills caused by volatile organic compounds (VOCs) such as methane and acetone. As hazardous materials are released from landfills, VOCs have been increased to avoid serious health problems for operators, workers, and residents.[16] Soil pollution from landfills has been proven to contain various dangerous organic compounds. Higher concentrations include benzene (3.7 ppm), followed by xylene (1.3 ppm), toluene (0.68 ppm), and ethylbenzene (0.61 ppm). Benzene emissions are the largest cause of concern at the landfills studied due to their carcinogenic properties and impact emissions exceeding acceptable limits. Given the

harmful effects of aromatic compounds such as benzene, toluene, and xylene, although their dangerous concentrations are not high compared to other gases in dump sites (less than 1% of the total volume), the most commonly observed VOCs in the air around the area are toxic, and in some cases carcinogenic, and will have a critical impact on air quality in the region.[17] Air pollution is usually caused by chemical compounds resulting from burning fossil fuels. Chemical compounds like CO and NOx gas can harm human health. Chemical compounds, such as CO_2, SO_2, and NO_2, can cause environmental damage due to acid rain and global warming.[18]

Impact on Health and Environment Problems

This study found that the most common disease was respiratory disorder. Respiratory disorder is the most dominant cause and has been studied for a long time since 2016. They would still be the main notion of discussion on the impact of pollution until 2023 (Figure 3). Respiratory problems have also been a peak problem during the COVID-19 pandemic. Anthropological sources were responsible for respiratory and cardiovascular diseases; hence, restricting social activities was the solution taken when a pandemic occurred.[19]



(a) **(b)**

Figure 3. (a) Various Health Impacts of Climate Change, (b) The Most Common Diseases Caused by Environmental Pollution

CO_2 gas can cause a greenhouse effect, and global warming can be understood through spectroscopic studies of the vibrational, rotational, and translational movements of CO_2 molecules. CO_2 molecules with asymmetric vibrations have one shorter and longer bond. Asymmetrical vibrations are active in infrared radiation because there is a change in dipole moment during vibration. Infrared radiation of 2,349 cm^{-1} excites asymmetric vibrations. The asymmetric vibration of 2,349 cm^{-1} is in the center of the absorption band (red, 2,100 – 2,400 cm^{-1}) as a heat radiation band, so it can act as a greenhouse gas that causes global warming and climate change.[20]

Climate change has been proven to impact health, increasing pollution and stress.[21] For the global warming concern in developed countries, the United States, for example, designs urban areas to include more plants to reduce heat-related deaths.[15] This condition is due to the ocean heat waves associated with the urban heat island effect, which can increase environmental temperatures in urban areas and is exacerbated by higher population density and more pollution, thereby posing a severe threat to population health with an increased risk of death.[22] Growing concerns about global warming, coastal pollution, and microbial contamination of live or raw seafood are known based on the detection of pathogenic bacteria *E. coli* in American oysters in South Texas waters, which humans then consumed.[16] Pollutants in waters are caused, among other things, by the impact of pesticides and chemical fertilizers, which have severe implications for human health, as well as increasing concerns about environmental pollution originating from modern agricultural practices, such as increased greenhouse gas emissions and water contamination.[23]

Climate change also impacts increasing volatile organic compounds (VOCs), which are most commonly observed in the air around these toxic locations, and in some cases carcinogenic, and would have a critical impact on air quality in the region.[18] The most extreme effect of global warming is a determinant in the incidence of hematological malignancies among black anemia patients.[13] Motorized vehicles and industrial activities are the largest contributors to carbon

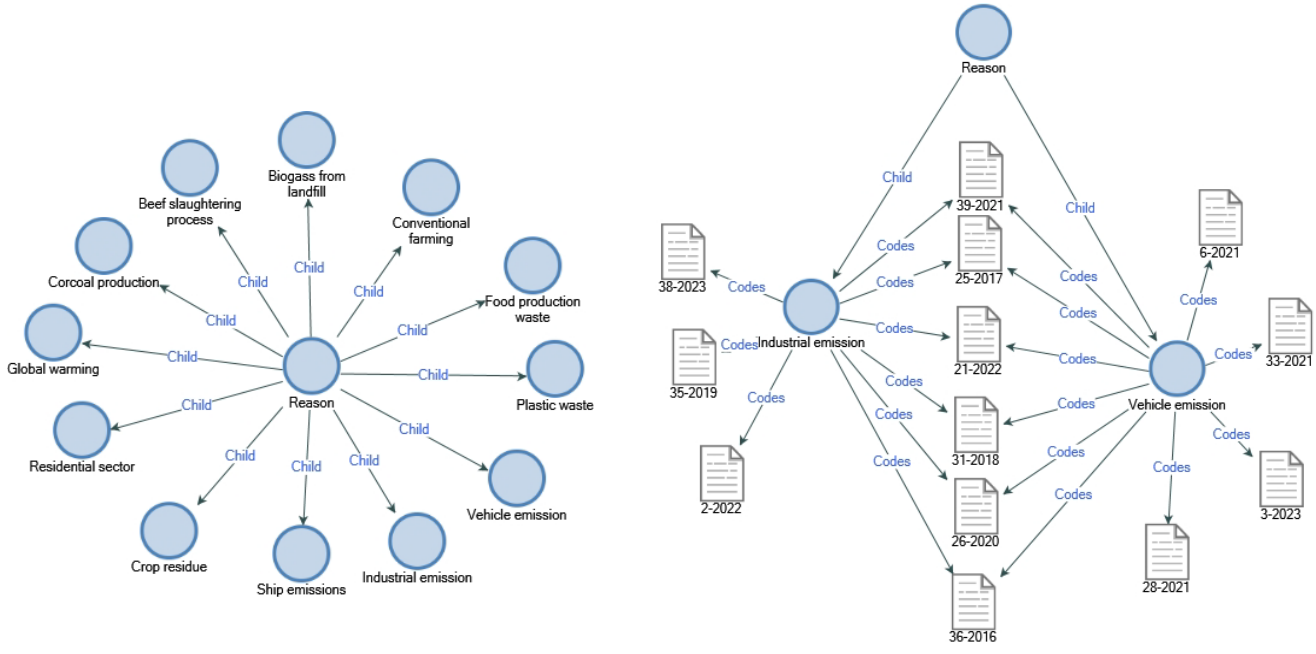
dioxide (CO_2) gas emissions, which reduces the environment, health, and air quality.[24] One of the causes was vehicle combustion, which produces CO gas. The gas released by cars was caused by incomplete combustion of fossil fuels, such as petroleum and natural gas. Carbon monoxide is a deadly gas without color, smell, or taste. Inhaling carbon monoxide causes serious injury to the brain, heart, and other vital organs. Respiratory insufficiency due to carbon monoxide poisoning increases troponin-I, creatine kinase-MB fraction levels, and carboxyhemoglobin.[18] CO gas can coordinate bonds with the central Fe atom in the porphyrin ring of hemoglobin 200 times stronger than the coordination bonds of the central Fe atom in the porphyrin ring with O_2 gas, which causes the supply of oxygen gas to cells and body tissues to be very limited so that symptoms of hypoxia can occur causing death.[19]

The combustion reaction of fossil fuels containing organic compounds, one of whose components is the element nitrogen, produces NO gas, which can be seen in the color of the leaves that turn brown. Furthermore, NO gas can undergo an oxidation reaction to produce NO_2 gas. The NO_2 gas undergoes a photochemical reaction with ultraviolet rays from the sunlight to produce NO gas and oxygen radicals. Oxygen radicals (O.) are very energetic and react very easily with O_2 to form ozone (O_3). The ozone formed then reacts with double bonds in unburned hydrocarbons in motor vehicle engines, NO and O_2, to produce compound PAN, which can cause irritation and pain in the eyes as well as various respiratory problems, such as shortness of breath, asthma, coughing, and others.[20]

NO_2 gas can react with H_2O molecules to produce HNO_3, which dissolves and falls with the rain, causing acid rain, which can cause groundwater to become acidic, causing plants to die. All biota that live in water also die because they cannot survive in acidic water, and iron corrosion accelerates, which causes massive damage to buildings and other infrastructure. Acid rain can also be contributed by SO_2 pollutants oxidized to SO_3 and then react with sulfuric acid to produce pyrosulphuric acid ($H_2S_2O_7$), which dissolves in water and produces sulfuric acid (H_2SO_4).[21]

Reason for Health and Environment Problems

The literature review revealed industrial and motor vehicle pollution (Figure 4). Several studies even showed that both factors were the main disadvantages in one study. These findings indicated that industrial activities and various oil-fueled vehicles predominantly cause health-related pollution.



(a) **(b)**

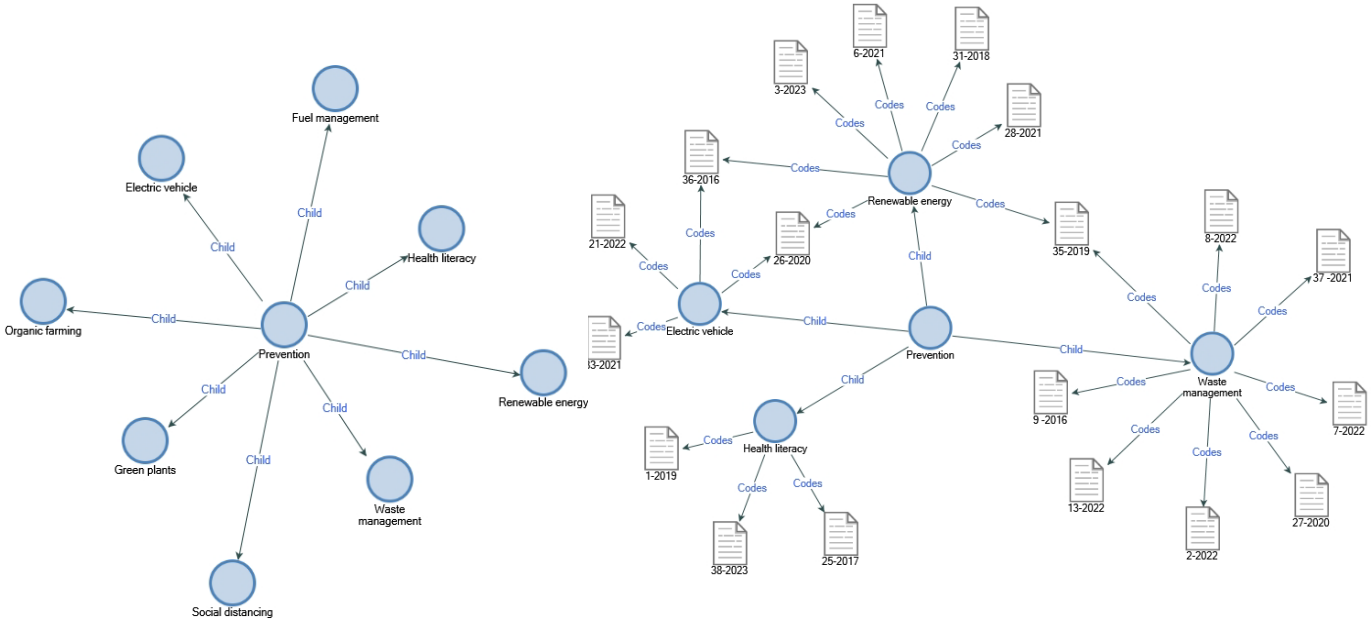
Figure 4. (a) Various Factors Causing Health Problems from Environmental Pollution, (b) The Most Dominant Source of Pollution Impacted Health Problems

Oil fields were found to be one of the factors resulting in the impact of disease on the community (Figure 4). Exhaust gas emissions, such as NO_x and CO, cause serious environmental pollution and dangers like global warming and respiratory problems. Many compounds in the form of greenhouse gases are also produced by water transportation. Used vehicle ships have the highest fuel consumption per ship, followed by general, cargo, and passenger ships.[22] The most frequent cause was transportation activities using oil fuel.

Sea water pollution impacts increasing water temperatures, showing a positive correlation with the proliferation of *E. coli*, which implies the effect of global warming and heat waves on the development and severity of oyster disease worldwide.[23] The next factor of charcoal production in soil should be addressed because it significantly increases soil pH, base saturation percentage, electrical conductivity, exchangeable base cations, and available P at charcoal production sites compared to the surrounding soil. Not only does the addition of charcoal produced during production affect nutrition, but it also affects the population and activity of microbes in the ground, including microbial interactions and habitat modification.[24]

Prevention and Solution of Health and Environment Problems

Studies stating solutions to disease-causing pollution mostly include renewable fuels, waste management, public health literacy, and the use of electric vehicles (Figure 5).



(a) **(b)**

Figure 5. (a) Various Alternative Solutions to Prevent the Impact of Pollution on Health, (b) Most Discussed Solutions to Prevent the Impact of Pollution on Health

Waste management is an effort to reduce emissions, and increasing biogas to biomethane is technically exciting. Since then, biomethane has been intended to be injected into the national gas grid or used as vehicle fuel. Biomethane is a versatile renewable fuel which can replace fossil natural gas and be used in combined heat and power (CHP) systems, distributed over small local gas networks, dedicated to public transport, or converted into hydrogen. In addition, vehicle biofuel produced from waste meets the European Union's requirements to reduce greenhouse gas emissions by up to 60% compared to current fossil fuels.[18]

One of the most appropriate solutions to overcome health problems and environmental damage caused by pollution from burning fossil fuels is eco-friendly renewable energy. The sunlight, which provides enormous energy, must be utilized using solar panels to store and distribute energy for industrial operations and household needs. Biodiesel or bioethanol obtained through the extraction of certain plants, such as sugar cane, can be explored to obtain an energy source that produces quite a lot of heat. Genetic engineering can also continue to be pursued by engineering the sucrose synthase enzyme so that microalgae can divert sucrose production to form more triglycerides that can be used as alternative fuel.[2] Mahua biodiesel blend is considered a safe renewable fuel for conventional engines because it increases energy efficiency. Mahua biodiesel mixed with n-butanol is used as test fuel in traditional engines. Mahua has a regular biodiesel-burning period. Mahua Biodiesel contains antioxidants, which makes it an environmentally friendly fuel.[4]

Solutions are starting to be developed in the form of electric vehicles (EVs). In addition to environmental benefits,

when compared with ICE vehicles, EVs have several advantages, including lower operating costs, less interior noise and vibration, low-speed acceleration, a convenient charging system, and zero exhaust emissions. They can also provide a great boost to the vehicle, economic, and industrial competitiveness by attracting investment in developing countries.[6] In addition, electric vehicles are an environmentally friendly alternative to conventional vehicles with high emissions. The key is the success of encouraging the adoption and diffusion of electric vehicles in developing countries, which must continue to be identified and evaluated for efficiency and performance optimization.[20]

Natural resources can be an important element in reducing various health risks. For example, increasing forestry activities can reduce environmental pressure by increasing forest capacity, thereby reducing health problems by providing cleaner air. Accordingly, a process consisting of three parts: increasing natural resources, reducing environmental pollution, and improving the quality of health is hypothesized to help reduce health spending and increase the efficiency of health spending.[8]

Organic farming systems can contribute to reducing production costs and increasing energy efficiency but are limited in reducing certain forms of environmental degradation. It is important to consider other alternatives to manage soil health and productivity, reduce environmental degradation, and mitigate global warming, ozone layer depletion, and climate change. This can ultimately play a significant role in overcoming the problem of climate change and its challenges.[19]

One of the advances in pollution prevention is technology-based, human-centered environmental design, including (1) using the core perspective of data mining, human-centered through AI, which investigates new visual phenomena occurring in the context of Web 4.0, as well as cross-border linkages and multidimensional characterized by graphic images; and (2) after correction, Web 4.0 shows that the same metric information can be found between exterior predictions and images correlated with pore structure, as shown in three-dimensional (3D) scenarios.[7]

An effort to avoid risks due to air pollution is made through sensitivity analysis by measuring the concentration of benzene in workers' breath, which is considered the most important factor for measuring carcinogenic and non-cancer risks. Therefore, active protective measures are important to reduce workers' exposure to risk factors. The implementation of personal protective equipment, specifically designed to eliminate the administration of inhaled VOCs and fit testing for each worker, is recommended. In addition, preventive steps to reduce the potential for workers to be exposed to carcinogenic compounds require reducing working hours or occasionally changing working hours, rotating workspaces from one location to another sequentially. Moreover, regular biological monitoring of metabolite compounds needs to be carried out in order to scientifically ascertain the level of danger that can be caused by exposure to these carcinogenic compounds.[18]

Conclusion

The use of fossil fuels is the main source of air pollution, which can cause health problems, especially respiratory problems due to CO, NO, NO_2, and SO_2 gases, as well as environmental damage, especially global warming due to CO_2 emissions. Some solutions to eliminate pollution that causes health problems and environmental damage include using renewable fuels, waste management, public health literacy, electric vehicles, reforestation, and tree planting movements. As a policy recommendation, the government must provide an environment supporting clean and renewable energy technologies for residential, commercial, and industrial purposes to reduce environmental pollution and its impact on health.

Abbreviations

ICE: Internal Combustion Engine; VOCs: Volatile Organic Compounds; EVs: Electric Vehicles.

Ethics Approval and Consent to Participate

This research does not require approval by the ethics committee because it is a research study of secondary data (literature study)

Competing Interest

The authors declare that there is no conflict of interest.

Availability of Data and Materials

Data is available when requested

Authors' Contribution

Conceptualization, methodology, and data analysis, EY, ID, and FADN; writing—original draft preparation, EY; resources, writing—review and editing, EY, LASM, ID, FADN, and A. All authors have read and agreed to the published version of the manuscript

Acknowledgment

Not applicable.

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