



Environmental Health Risk Assessment of Industrial Activities and Their Impact on Public Health in Indonesia: A Systematic Literature Review

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Abstract. Industrial development in Indonesia has contributed significantly to economic growth; however, it has also increased environmental pollution and public health risks. Industrial activities produce various pollutants that contaminate air, water, and soil, potentially causing adverse health effects among exposed populations. This study aimed to identify environmental health risks associated with industrial pollution and their impacts on public health in Indonesia. A systematic literature review was conducted following the PRISMA 2020 guidelines. Literature searches were performed in PubMed, Google Scholar, ScienceDirect, Scopus, and SpringerLink databases using relevant keywords. Original research articles published between 2014 and 2025 were screened based on predetermined inclusion and exclusion criteria, resulting in ten eligible studies included in the review. Data were synthesized narratively according to industrial sources, environmental exposures, study populations, and health outcomes. The findings identified four major environmental exposures, namely air pollution, dust exposure, heavy metal contamination, and industrial wastewater pollution. Respiratory disorders were the most frequently reported health outcomes, followed by cardiovascular diseases, neurological disorders, kidney impairment, and carcinogenic risks. Communities and workers living near industrial areas were identified as the most vulnerable populations due to prolonged environmental exposure. In conclusion, industrial pollution remains an important environmental health issue in Indonesia. Strengthening environmental monitoring systems, implementing stricter industrial emission control policies, and conducting routine environmental health risk assessments are necessary to reduce health risks and support sustainable industrial development.

Keywords: environmental health risks; industrial pollution; Indonesia; public health; systematic literature review.

1. BACKGROUND

Industrialization has become an important driver of economic growth in Indonesia. Rapid development in manufacturing, mining, petrochemical, metal processing, and energy sectors has increased national productivity, employment opportunities, and regional economic development. However, industrial expansion has also generated considerable environmental challenges, particularly through increased emissions, hazardous waste production, and contamination of environmental media such as air, water, and soil (Nasution et al., 2024). Environmental degradation resulting from industrial activities has emerged as an important public health concern because environmental pollutants can directly or indirectly affect human health through multiple exposure pathways (TUK Indonesian 2024).

Globally, environmental pollution contributes substantially to morbidity and mortality. According to the World Health Organization, environmental risk factors account for a significant proportion of preventable diseases, especially respiratory diseases, cardiovascular diseases, cancers, neurological disorders, and infectious diseases associated with poor environmental sanitation (World Health Organization, 2016). Environmental Health Risk Assessment (EHRA) has therefore become an important approach to identify hazards, assess population exposure, estimate potential health effects, and support evidence-based decision

making in environmental health management (enHealth, 2012). EHRA evaluates various environmental hazards, including chemical contaminants in air, water, soil, and food, that may adversely affect human health.

Indonesia is currently facing increasing environmental health challenges due to rapid urbanization and industrialization. Several studies have reported that anthropogenic activities, including industrial processes and transportation, are major contributors to environmental contamination throughout the country (Nasution et al., 2024). Industrial areas commonly release particulate matter, sulfur dioxide (SO₂), nitrogen dioxide (NO₂), heavy metals, and other hazardous pollutants into the environment, thereby increasing community exposure risks and creating long-term health consequences, especially among populations living near industrial zones (Rivai et al., 2023).

Air pollution is one of the most frequently reported environmental problems associated with industrial activities in Indonesia. Long-term exposure to air pollutants has been associated with upper respiratory tract infections, asthma, chronic obstructive pulmonary disease, cardiovascular diseases, and reduced quality of life. In addition, environmental contaminants may accumulate in water bodies and agricultural land, creating further risks through food chains and household water consumption (Syuhada et al., 2023). Communities residing near industrial sites are generally considered vulnerable populations because continuous exposure may increase both acute and chronic health problems (Kemenkes RI, 2012).

Environmental health risk assessment studies in Indonesia have also demonstrated the potential health impacts of industrial emissions. An environmental risk analysis among industrial workers in Jambi showed that long-term dust exposure could increase future health risks despite pollutant concentrations remaining below regulatory thresholds (Guspianto et al., 2021). Similarly, exposure to industrial pollutants such as SO₂, NO₂, and particulate matter has been identified as an important environmental health concern requiring continuous monitoring and preventive interventions.

Although numerous studies have investigated specific environmental pollutants and their health effects in Indonesia, the available evidence remains fragmented across industrial sectors and geographical areas. Existing studies tend to focus on a single type of exposure, specific pollutants, or individual industrial regions. Consequently, a comprehensive synthesis of evidence regarding environmental health risks arising from industrial activities and their impacts on public health in Indonesia is still limited. Therefore, a systematic literature review is necessary to summarize current evidence regarding environmental exposures, affected

populations, and associated health outcomes to support environmental management policies and public health interventions in Indonesia.

2. THEORETICAL STUDY

Industrial activities are recognized as one of the major contributors to environmental degradation and public health problems worldwide. Industrial processes generate various pollutants, including particulate matter, greenhouse gases, heavy metals, organic compounds, and hazardous wastes that can contaminate environmental media such as air, water, and soil. These pollutants may enter the human body through inhalation, ingestion, and dermal contact, resulting in both short-term and long-term health consequences (World Health Organization, 2016).

Environmental Health Risk Assessment (EHRA) is a systematic approach used to identify environmental hazards, evaluate exposure pathways, estimate potential health impacts, and support decision-making for environmental management (enHealth, 2012). EHRA generally consists of four main components: hazard identification, exposure assessment, dose-response assessment, and risk characterization. This approach has become increasingly important in industrial areas because populations living near industrial facilities are continuously exposed to multiple environmental contaminants.

In Indonesia, rapid industrialization has accelerated economic growth while simultaneously increasing environmental health challenges. Previous studies have reported associations between industrial activities and various health problems, including respiratory diseases, skin disorders, gastrointestinal diseases, cardiovascular diseases, and neurological disorders caused by prolonged exposure to environmental pollutants (Syuhada et al., 2023; Nasution et al., 2024). Therefore, understanding environmental health risks associated with industrial activities is essential to support evidence-based interventions, strengthen environmental monitoring systems, and develop effective public health policies to protect communities residing near industrial areas.

3. RESEARCH METHODS

Design Study

This study employed a Systematic Literature Review (SLR) design to synthesize evidence regarding environmental health risks resulting from industrial activities and their impacts on public health in Indonesia. The review was conducted following the Preferred

Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency and consistency throughout the review process (Page et al., 2021).

Search Strategy

Literature searches were conducted in three electronic databases, namely Google Scholar, PubMed, and Scopus. The search process was performed from January to March 2026. The following keywords and Boolean operators were used: ("industrial activities" OR "industrial pollution" OR "industrial emissions") AND ("environmental health risk assessment" OR "environmental health") AND ("public health") AND ("Indonesia").

Eligibility Criteria

The inclusion criteria were: (1) original research articles published between 2015 and 2025; (2) studies conducted in Indonesia; (3) studies discussing industrial activities and their impacts on environmental health and public health; (4) full-text articles available; and (5) articles published in English or Indonesian. The exclusion criteria were: (1) review articles, editorials, conference proceedings, theses, and dissertations; (2) duplicate publications; and (3) studies that did not report health outcomes related to environmental exposure.

Study Selection

All identified articles were screened independently based on title, abstract, and full-text eligibility. Duplicate studies were removed during the initial screening process.

The remaining articles were evaluated according to the inclusion and exclusion criteria. Any disagreements during the selection process were resolved through discussion among the researchers. The final review included ten eligible studies.

Data Extraction

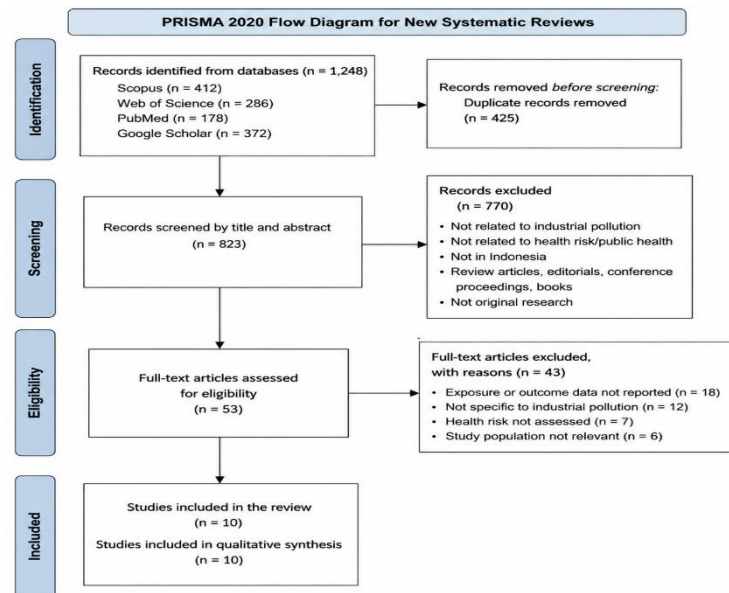
Data extraction was performed using a standardized extraction form that included author names, publication year, study location, industrial sector, environmental exposure, study design, population characteristics, and reported health outcomes.

Data Synthesis

A narrative synthesis approach was employed to summarize and categorize the findings. The included studies were grouped according to the main environmental exposure pathways, including air pollution, water contamination, heavy metal exposure, and hazardous

chemical exposure. The associated public health outcomes were then identified and summarized descriptively.

Figure 1. PRISMA Flow.



4. RESULTS AND DISCUSSION

Table 1. Characteristics of Included Studies (n=10).

No	Author (Year)	Study Location	Industrial Source	Environmental Exposure	Study Population	Health Impact
1	Syuhada et al. (2023)	Jakarta	Urban-industrial activities	PM2.5, O3	General population	Respiratory disease, cardiovascular disease, premature mortality
2	Guspianto et al. (2021)	Jambi	Cassia processing industry	Dust exposure	Industrial workers	Respiratory disorders, eye irritation, skin irritation
3	Fahimah et al. (2023)	Citarum, West Java	Industrial activities along Citarum watershed	Heavy metals in water	Communities around river areas	Neurological disorders, kidney disorders, carcinogenic risk
4	Gusti et al. (2019)	Padang	Industrial and traffic emissions	SO2, NO2	Market traders	Respiratory irritation, asthma risk
5	Maksuk et al. (2022)	Gowa, South Sulawesi	Weaving industry	Dust exposure	Communities around industrial centers	Respiratory disorders, eye irritation
6	Ahmad et al. (2014)	Probolinggo, East Java	Industrial area	Total Suspended Particulate (TSP)	Communities around industrial areas	Reduced lung function, respiratory disorders

7	Indriyani et al. (2017)	Semarang, Central Java	Furniture industry	Wood dust	Furniture workers	Respiratory disorders, eye irritation
8	Agustiani et al.	Gunung Pongkor, West Java	Gold mining industry	Mercury (Hg)	Communities around mining areas	Neurological disorders and chronic toxicity
9	Rauf et al.	Maros, South Sulawesi	Industrial area	Heavy metals in atmospheric particulate matter	Communities around industrial areas	Respiratory disorders and chronic health risks
10	Rauf et al.	Maros, South Sulawesi	Cement industry	Total Suspended Particulate (TSP)	Communities around cement plants	Respiratory disorders

This systematic literature review identified four major environmental exposures associated with industrial pollution in Indonesia, namely air pollution, dust exposure, heavy metal contamination, and industrial wastewater pollution. These environmental hazards were consistently associated with adverse public health outcomes, particularly respiratory disorders, cardiovascular diseases, neurological disorders, kidney impairment, and long-term carcinogenic risks. The findings indicate that communities and workers living near industrial areas remain vulnerable to environmental health risks due to prolonged exposure to environmental contaminants.

Air pollution was the most frequently reported environmental exposure among the included studies. Several studies highlighted particulate matter PM_{2.5}, ozone (O₃), sulfur dioxide (SO₂), and nitrogen dioxide (NO₂) as major contributors to adverse health outcomes. Syuhada et al. (2023) reported that PM_{2.5} exposure in Jakarta substantially increased premature mortality and the burden of respiratory and cardiovascular diseases. Similarly, Gusti et al. (2019) demonstrated that exposure to SO₂ and NO₂ increased respiratory health risks among exposed populations. These findings support previous evidence that long-term exposure to airborne pollutants contributes significantly to disease burden, particularly in densely populated industrial and urban areas.

Dust exposure also emerged as an important environmental hazard. Studies conducted in Jambi, Gowa, Semarang, and Probolinggo demonstrated that exposure to industrial dust may increase the risk of respiratory disorders, eye irritation, and reduced lung function. Workers and communities surrounding industrial facilities are particularly susceptible because exposure occurs continuously over long periods. Inhalation remains the primary route of exposure, making respiratory disorders one of the most common health outcomes identified in this review.

Heavy metal contamination was another major environmental concern identified in this study. Heavy metals, including lead (Pb), cadmium (Cd), chromium (Cr), and mercury (Hg), were found in both water and air around industrial and mining areas. Several studies reported potential neurological disorders, kidney dysfunction, and increased carcinogenic risks associated with long-term exposure. Communities living near industrial watersheds and mining activities were among the most vulnerable groups because environmental contaminants may accumulate through multiple pathways, including drinking water consumption, food chains, and inhalation exposure.

Overall, this review suggests that industrial pollution remains an important public health issue in Indonesia. Environmental monitoring systems, stricter industrial emission regulations, and routine environmental health risk assessments are needed to minimize health risks among exposed populations. In addition, collaborative efforts involving government agencies, industries, public health professionals, and local communities are essential to strengthen preventive strategies and improve environmental quality. Future studies are encouraged to conduct longitudinal assessments to better understand the long-term impacts of industrial pollution on population health.

5. CONCLUSION

This systematic literature review demonstrated that industrial pollution remains an important environmental health issue in Indonesia. The ten included studies consistently identified air pollution, dust exposure, heavy metal contamination, and industrial wastewater pollution as major environmental hazards affecting both workers and communities living near industrial areas. Respiratory disorders were the most frequently reported health outcomes, followed by cardiovascular diseases, neurological disorders, kidney impairment, and increased carcinogenic risks associated with long-term exposure.

The findings suggest that continuous environmental exposure from industrial activities may substantially increase the burden of disease among vulnerable populations. Therefore, strengthening environmental monitoring systems, implementing stricter industrial emission control policies, and conducting routine environmental health risk assessments are essential to reduce adverse health impacts. Collaboration among government agencies, industries, health professionals, and local communities is also necessary to promote sustainable industrial development while protecting public health in Indonesia. Future research should focus on long-term population-based studies to provide stronger evidence regarding the health impacts of industrial pollution.

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