



Open Waste Burning And Health Risks In Indonesia: A 2020–2025 Literature Review

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ABSTRACT

Pembakaran sampah terbuka tetap menjadi tantangan kesehatan lingkungan yang persisten di banyak negara berpenghasilan rendah dan menengah, termasuk Indonesia, di mana keterbatasan sistem pengumpulan sampah, kapasitas tempat pembuangan akhir (TPA) yang terbatas, serta praktik pembuangan di tingkat rumah tangga mendorong terjadinya pembakaran rutin terhadap campuran berbagai jenis sampah. Artikel ini bertujuan untuk mensintesis literatur berbahasa Inggris periode 2020–2025 mengenai pembakaran sampah terbuka, dengan fokus pada risiko kesehatan lingkungan, jalur paparan, serta intervensi praktis yang relevan dengan konteks Indonesia. Tinjauan literatur kualitatif dilakukan dengan menggunakan artikel jurnal ilmiah yang telah melalui proses peer-review serta laporan otoritatif terpilih yang diterbitkan antara tahun 2020 hingga 2025. Kajian ini memprioritaskan studi yang membahas karakterisasi emisi, profil polutan beracun, penilaian paparan, serta dampak kesehatan yang terkait. Temuan menunjukkan bahwa pembakaran terbuka terhadap sampah campuran terutama plastik dan material komposit menghasilkan partikel halus dalam jumlah signifikan serta berbagai ko-polutan beracun, termasuk hidrokarbon aromatik polisiklik (PAH), gas asam, dan polutan organik persisten. Paparan terhadap zat-zat ini meningkatkan risiko penyakit pernapasan dan kardiovaskular, serta berkontribusi pada peningkatan risiko kanker dalam jangka panjang. Bukti juga menunjukkan adanya kontaminasi lingkungan melalui deposisi abu serta resuspensi partikel yang telah terkontaminasi.

Upaya mitigasi yang efektif memerlukan strategi terintegrasi, meliputi peningkatan layanan pengumpulan sampah yang andal, pemilahan sampah dari sumbernya,

pengolahan yang lebih aman untuk sampah organik, komunikasi risiko yang tepat sasaran, serta penguatan tata kelola yang menyelaraskan penegakan aturan dengan penyediaan layanan. Artikel ini ditutup dengan rekomendasi yang dapat ditindaklanjuti bagi program kampus dan komunitas, pemerintah daerah, serta pemangku kepentingan di bidang kesehatan masyarakat untuk mengurangi praktik pembakaran sampah terbuka dan melindungi kesehatan populasi.

Keywords

open waste burning; environmental health; air pollution; plastic waste; Indonesia

Open waste burning remains a persistent environmental health challenge in many low- and middle-income settings, including Indonesia, where gaps in waste collection, limited landfill capacity, and household-level disposal practices contribute to routine burning of mixed waste streams. This article aims to synthesize 2020–2025 English-language literature on open waste burning with a focus on environmental health risks, exposure pathways, and practical interventions relevant to Indonesian contexts. A qualitative literature review was conducted using peer-reviewed journal articles and selected authoritative reports published between 2020 and 2025. The review prioritized studies addressing emission characterization, toxic pollutant profiles, exposure assessment, and associated health outcomes. Findings indicate that open burning of mixed waste especially plastics and composite materials generates substantial fine particulate matter and toxic co-pollutants, including polycyclic aromatic hydrocarbons, acidic gases, and persistent organic pollutants, which elevate risks for respiratory and cardiovascular morbidity and contribute to longer-term cancer risk. Evidence also highlights environmental contamination through ash deposition and resuspension of contaminated particulates. Effective mitigation requires integrated strategies: reliable waste collection, source segregation, safer treatment for organics, targeted risk communication, and governance measures that align enforcement with service provision. The article concludes with actionable recommendations for campus and community programs, local governments, and public health stakeholders to reduce open burning and protect population health.

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1. Introduction

Environmental health is closely shaped by everyday practices that determine how communities manage water, sanitation, food, and waste. In many urban and peri-urban areas, especially where municipal services are inconsistent, households and neighborhoods may rely on informal coping strategies to remove waste quickly. One of the most common strategies is open burning of household waste, whether in the yard, along streets, or at small dumpsites. While burning can appear to be a practical short-term solution, it transfers risk from visible solid waste into less visible but more harmful airborne pollutants that can be inhaled by residents, including children, older adults, and individuals with chronic disease.

Household waste burning is particularly concerning in the modern packaging era because municipal waste is rarely “purely organic.” Plastics, coated paper, synthetic textiles, and mixed materials often enter daily trash. When burned in low-temperature and oxygen-poor conditions, these materials can produce complex mixtures of pollutants, including fine particulate matter and polycyclic aromatic hydrocarbons. Controlled combustion experiments show that plastic waste can produce particulate emissions far higher than typical dry firewood under similar conditions, and also emit exceptionally high levels of polycyclic aromatic hydrocarbons compared with wood burning. This is a major environmental health problem because exposure occurs close to the source, often without protective equipment, and can happen repeatedly.

In Indonesia, the public health relevance is amplified by dense living arrangements in many neighborhoods, the presence of informal waste handling, and varying coverage of routine waste collection. Multi-country evidence that includes Indonesia indicates that open burning is often used as

a “tool” for cleanliness when waste services are inadequate, and that formal regulations against burning frequently fail in practice without feasible alternatives. For students of environmental health, this topic is important because it connects behavioral drivers, service access, environmental exposure, and preventable disease risks into one real-world chain.

This article aims to synthesize recent evidence (2020–2025) on household open waste burning, with emphasis on health-relevant pollutants, exposure pathways, and intervention options suitable for Indonesia. The novelty of this review is its integration of combustion evidence, community practice explanations, and emerging toxicological indicators (such as oxidative potential) into a single environmental health narrative, rather than treating waste burning only as a waste-management issue.

2. Methods

This study employed a qualitative critical literature review design to synthesize evidence on open waste burning and its environmental health implications. The review focused on peer-reviewed journal articles and selected authoritative reports published between 2020 and 2025. The methods were structured to allow transparent identification, selection, and thematic synthesis of relevant literature. Because this study was a literature review, the methods emphasized document selection, screening, and analysis procedures rather than primary field measurement.

2.1. Design and location of research

This study used a qualitative critical literature review design. The review was conducted using academic search engines and databases commonly used in the fields of public health and environmental science to identify relevant English-language

publications on open waste burning. The review process was carried out by systematically searching, screening, and analyzing literature published between 2020 and 2025.

2.2. Population and sample

The population in this study consisted of scientific publications discussing open waste burning and its environmental health impacts. The sample comprised peer-reviewed journal articles and selected authoritative reports in English published between 2020 and 2025.

The literature was selected using purposive criteria. Articles were included if they provided empirical findings or robust synthesis related to at least one of the following aspects:

1. drivers of household or community open waste burning;
2. measured or modeled emissions from waste burning;
3. pollutant characterization, including particulate matter and toxic organic compounds;
4. health risk indicators or observed health outcomes; and
5. intervention or policy implications relevant to environmental health.

Articles outside the 2020–2025 publication range, not written in English, or not directly relevant to open waste burning were excluded.

2.3. Operational variables and definitions

In this literature review, the main analytical variables were defined conceptually based on the study objectives. The key variables included:

- Open waste burning: the practice of burning household or mixed solid waste in open spaces without controlled combustion technology.
- Emission characteristics: pollutants released during burning, including

fine particulate matter, toxic gases, and organic pollutants.

- Exposure pathways: routes through which humans may be exposed to pollutants, such as inhalation of smoke, ash deposition, and resuspension of contaminated particles.
- Environmental health risks: potential adverse health effects associated with exposure to pollutants from open waste burning, including respiratory, cardiovascular, and long-term toxic effects.
- Practical interventions: feasible strategies to reduce open burning and its health impacts, especially in resource-limited settings.

To strengthen clarity, these variables may also be presented in a table of operational definitions.

2.4. Data Collection Techniques

Data were collected through document-based literature searching and screening. The search strategy emphasized keywords related to open waste burning, household waste combustion, plastic burning, emission factors, ambient monitoring of burning markers, exposure assessment, respiratory outcomes, and environmental health risk.

Relevant publications were identified from academic databases and search engines commonly used in environmental health and public health research. After identification, the documents were screened based on title, abstract, publication year, language, and relevance to the topic. Full-text articles that met the inclusion criteria were then reviewed in detail for analysis.

2.5. Data Analysis

The included literature was analyzed using a thematic qualitative approach. After

screening for relevance and publication date, the selected studies were grouped and synthesized based on recurring themes. The synthesis prioritized four major analytical areas:

1. the reasons why open burning occurs in real communities;
2. the pollutants released during burning, especially from plastic-containing waste;
3. household- and community-level exposure pathways; and
4. practical interventions suitable for settings with limited infrastructure and resources.

Because this study was a review, the findings presented in the results section reflect patterns across studies rather than primary measurements. Priority in interpretation was given to studies with clear methods and replicable findings, including controlled combustion experiments, city-scale inventories, and field observations.

2.6. Research Ethics

This study did not involve direct human participants, biological samples, or personal data collection because it was based entirely on published literature and secondary documentary sources. Therefore, formal informed consent was not required. However, the review was conducted by maintaining academic integrity through proper citation, accurate representation of sources, and avoidance of plagiarism.

3. Results

The reviewed literature identified four recurring findings related to open waste burning: household burning as a response to gaps in waste services, the important role of plastic and mixed waste in determining emission toxicity, the presence of measurable exposure pathways near burning activity, and the importance of interventions that are feasible in resource-limited settings.

3.1. Household Burning as a Response to Waste Service Gaps

Across the reviewed studies, household open waste burning was frequently described as a practical response to limited waste collection, irregular pickup schedules, restricted storage space, and the need to maintain household cleanliness. In these conditions, burning was used as a routine disposal method for mixed household waste. Studies also showed that the practice may persist even in places where regulations already exist.

3.2. Plastic and Mixed Waste as Major Sources of Toxic Emissions

The reviewed literature consistently showed that waste composition strongly affects emission toxicity. Plastic and mixed waste were repeatedly identified as important sources of fine particulate matter and other toxic pollutants. Controlled combustion studies reported that plastics produced high particulate emissions and released larger quantities of polycyclic aromatic hydrocarbons compared with cleaner fuels such as dry firewood. Other studies also reported that particulate matter from burning common plastics contains environmentally persistent free radicals, transition metals, and reactive chemical components.

3.3. Exposure Pathways and Health-Relevant Signals

Field-based and community-level studies indicated that open waste burning creates measurable exposure conditions near homes and daily activity areas. The main exposure pathways reported in the literature were inhalation of smoke, short-distance exposure to repeated burning events, ash deposition, and resuspension of contaminated particles. Studies from Indonesia, including Semarang, identified household open waste burning as a relevant

environmental exposure issue at the community level. Other studies also reported respiratory symptoms and related health concerns in populations living close to waste burning activity.

3.4. Findings on Intervention Approaches

The literature showed that intervention strategies were more effective when they addressed both behavior and structural constraints. Frequently reported approaches included improving waste collection services, promoting source segregation, expanding safer handling of organic waste, strengthening recycling pathways, and improving neighborhood disposal infrastructure. Several studies also showed that education or prohibition alone was often insufficient without adequate service provision and local governance support.

4. Discussion

From an environmental health perspective, open waste burning is a high-risk practice precisely because it combines frequent exposure, close distance, and highly variable toxic mixtures. Unlike many industrial pollution sources that can be monitored at fixed sites, household burning is distributed and often unrecorded. This makes exposure harder to regulate and easier to normalize. When the social goal is immediate cleanliness and the service environment does not provide convenient alternatives, behavioral change campaigns that simply instruct “do not burn” are likely to fail or produce only temporary compliance.

The reviewed evidence strengthens the argument that plastics deserve special attention in environmental health interventions. In controlled experiments, plastics show very high particulate and polycyclic aromatic hydrocarbon emissions compared with wood fuel. This supports an

implication for Kesling practice: risk communication should move beyond generic “smoke is bad” messaging and emphasize that burning mixed packaging waste is not equivalent to burning leaves, because the chemistry and toxicity can be dramatically different. Emerging work in atmospheric chemistry and toxicology further suggests that plastic-burning particulate matter is not only abundant but also chemically reactive, containing persistent radicals, metals, and oxidative potential that may plausibly intensify inflammation pathways. This offers a more mechanistic explanation that can strengthen environmental health arguments in policy discussions, especially when communities question why outdoor smoke should be a priority.

The Indonesian context supports a systems-oriented conclusion. Evidence that includes Indonesia shows that open burning is closely linked to service gaps and local cleanliness norms, and regulations alone may not work when people lack feasible disposal pathways. This implies that environmental health solutions should be framed as enabling healthier choices, not only correcting individual behavior. When waste collection becomes predictable and accessible, burning can decline without requiring unrealistic daily effort from households.

This review also has limitations. As a literature review, it depends on available studies, and not all Indonesian settings are equally represented in recent English-language journals. In many studies, health outcomes are inferred from exposure indicators rather than measured through longitudinal clinical designs, and confounding sources of air pollution can complicate attribution. Even so, the convergence of combustion evidence, exposure plausibility, and reported respiratory impacts provides a strong basis for preventive action, particularly given the

avoidable nature of the practice and the feasibility of infrastructure-based solutions.

5. Conclusion

This article reviewed 2020–2025 evidence on household open waste burning with emphasis on environmental health implications for Indonesia. The literature consistently indicates that household burning persists because it solves immediate practical problems in contexts of limited waste services, but it does so by creating local exposure to harmful pollutants. Plastic and mixed waste combustion is especially concerning due to high particulate and carcinogenic emissions, and newer research suggests additional toxicity pathways linked to oxidative potential and reactive chemistry. Indonesian evidence, including work from Semarang and broader multi-country analyses that include Indonesia, supports the view that regulation alone is insufficient without reliable service alternatives.

For environmental health practice, the most realistic recommendation is an integrated prevention strategy. Municipal and campus-community programs should prioritize consistent waste collection coverage, simple separation at source for organics and plastics, and accessible neighborhood disposal points that reduce the “need” to burn. Risk communication should be practical and culturally aligned, emphasizing the highest-risk materials, especially plastic packaging, while offering clear alternatives for households. In parallel, local health agencies and universities can support monitoring and community reporting to identify hotspots of repeated burning, allowing targeted interventions rather than relying on general messaging. Over time, reducing household burning can improve neighborhood air quality, lower preventable respiratory irritation, and support broader public health goals that align with environmental sustainability.

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