

A Systematic Review of the Environmental and Health Impact of Fires at Landfills

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Abstract

The purpose of this study is to perform a systematic review of related literature on the environmental and health impacts of fires at landfills. There has been an increasing amount of municipal solid waste in developing countries, which has contributed to frequent fires occurring at landfill sites. Residents have been affected by these fires, especially because the landfills are located close to several densely populated residential communities. The philosophical foundation guiding this research is pragmatism. Additionally, the theoretical perspective that is closely linked to pragmatism and is guiding this research is the environmental justice theory. Consequently, the results obtained will be analyzed to form the basis on which future studies can be done, and legislation and policies can be developed to protect the environment, enhance the quality of social and economic lives of the citizens who reside in the vicinity of the landfills. The methodology, will involve a systematic review of pertinent materials, which will be used to answer the following questions: (1) What environmental and health effects of fires at landfill on the public?, (2) To what extent are the local communities impacted by fires at landfills?.

Keywords: Landfill; Municipal solid waste; Site; Treatment; Management

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Introduction

Global cities produced approximately 2 billion tons of Municipal Solid Waste (MSW) annually [1-5]. Therefore, the collection and management of MSW is a very demanding undertaking in cities around the world [6-10]. For this reason, the production and disposal of MSW have become a matter of great concern to many countries as they struggle to find appropriate ways to manage the situation [11]. Furthermore, scholars like Ferronato and Torretta highlighted that the contamination of the environment due to the mismanagement of waste requires continuous initiative and sustainable planning to militate against any possible impact. Therefore, researchers have outlined that “almost all the cities in the world are struggling to meet their waste reduction targets” [12].

Nevertheless, Olawoye, et al. and Nanda and Berruti pointed out that there are several methods that are used for MSW disposal and management, which includes: landfilling, recycling, thermal and biological treatment [13]. Consequently, Gokcekus, et al. in their study found that landfilling is a preferred way of MSW disposal because it is a significantly cost effective

technique that has become a common method around the world. Additionally, in studies conducted by Llanes and Kalogirou and Kaza et al. the researchers found that in low and middle income countries like Latin America and the Caribbean including Jamaica, the management of MSW is more difficult to control and streamline because “land filling is the most common waste disposal route adopted” [14,15]. Therefore, scholars like Mazzucco, et al. suggested that landfilling should only be the last option when it comes to the disposal of MSW in cities as there have been growing reports about the negative impacts that landfill fires are having on the environment, economy and on people’s health as these impacts may occur through leakages to the soil, air or water [16]. Similarly, Mikalsen et al., Aliu, Peter et al. and Vaverková have outlined that landfill fires are great concern and can have a significant impact on the environment and health which can result in substantial cost to life and property [17-19].

Therefore, in the Jamaican context, landfilling is the preferred method of waste disposal. Consequently, Riverton city landfill, which is the most active and largest of eight other landfills sites across the country, is frequently plagued by fires Jamaica

Environment Trust (JET). The amount of MSW received at the Riverton City Landfill equates to approximately 500 tons per day [20]. These materials, according to Duncan, are very combustible and will burn quite easily in the event of a fire. Fires at Riverton City Landfill have now become a regular occurrence. Furthermore, a historical review revealed that 415 fires occurred at the location over the period 1996 to 2015 Jamaica Fire Brigade (JFB). According to the JFB, some of these incidents affected residents within the Kingston Metropolitan Area and St. Catherine. This is so because residents often get sick after the fire event and have to seek medical attention. According to Duncan, after a fire event in 2015, over 3000 citizens had to seek medical attention for various illnesses. The philosophical foundation guiding this research is pragmatism because pragmatism is not committed to any one system of philosophy and reality. Additionally, pragmatism inquiries generally draw liberally from quantitative and qualitative assumptions when they engage in their research [21]. Additionally, the theoretical perspective that is closely linked to pragmatism and is guiding this research is the environmental justice theory. This theory has emerged as bridging social justice and environmental protection [22]. Mitchell furthered that environmental justice is very broad, and the theory addresses various issues, including risk and consequences between peoples' anthropogenic activities and the natural environment. Therefore, this systematic review study is designed to research the socio-economic, environmental and health impacts of landfill fires at Riverton city on the Kingston Metropolitan Area and St. Catherine. In doing so, the study attempted to answer the under mentioned research questions:

- What environmental and health effects of fires at landfill on the public?
- To what extent are the local communities impacted by fires at Landfill?

Literature Review

Purpose of the Study

The purpose of this study is to perform a systematic review of related literature on the socio-economic, environmental and health impacts of fires at landfills. The researcher seeks to retrieve information to form the basis on which future studies can be done and legislation and policies can be developed to protect the environment, enhance the quality of social and economic lives of the citizens who reside in the vicinity of the landfill.

Organization of the paper

The rest of the paper is organized into three parts, namely, methods, results, and conclusion. The brief descriptions of the methods include the procedures used in the review for selection and quality control for the papers reviewed. The result outlines plans of how the findings will be used and limitations encountered during the study. Finally, the paper culminates with concluding remarks outlining summary and gaps found in the literature reviewed.

Methods

The search criteria, selection of study, data abstraction and

assessment of the quality of data were defined and informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines (PRISMA). Consequently, given the aim of this study, a systematic review is considered the most appropriate analytical method. Therefore, this study was done to review and evaluate studies conducted on the socio economic, environmental and health impacts of landfill fires. Furthermore, a two-step process was adopted and utilized in the identification and selection of relevant studies. Firstly, the author reviewed the title and abstract of articles retrieved from major academic databases to select those that are potentially relevant to the studies for further examination. Detailed online search of a series of major academic research databases such as Google Scholar, EBSCO, ERIC and Science Direct. The search was conducted in English using the following keywords: Municipal solid waste, dumpsite, landfill fires. All databases were searched from 2017 to 2021. One thousand three hundred and forty articles were identified from the search. The titles and abstracts of the articles were properly screened in order to ensure that the inclusion criterion was met. Five hundred and ninety one met this requirement and were considered to be suitable and potentially relevant to the analysis. Consequently, a total of 81 articles were analyzed for eligibility and whether they contain the requisite data for a systematic review.

Methods used for Selection (Inclusiveness and exclusiveness)

For this analysis, an article was deemed eligible for inclusion based on the following: (1) Quantitative study that investigated landfill fires and provided analysis of its impact on the environment and citizens. (2) Qualitative study that also investigated landfill fires and provided rich information on its impact on the environment and citizens. Consequently, 10 articles met the inclusion criteria. Literature reviews were not considered to be included in this study. The titles, abstracts and keywords of the retrieved studies were reviewed, and irrelevant studies were omitted (completely different topics); all remaining titles and abstracts were reviewed for further decision. If it was not clear if the criteria were met by just reading the title or abstract of the paper, a full version of the mentioned document was retrieved and reviewed. Articles that reached the final criteria were downloaded and read in detail more than once. Furthermore, the articles selected were screened through the application of the following criteria:

- Publication date (from 2017 to 2021)
- Topic and keywords (the socio-economic, environmental and health impact of landfill fires)

- Language (articles that are written in English)

- Peer reviewed articles were included

The exclusion criteria for the studies in the systematic reviews are as follows:

- Language (articles that are not written in English)

- Lack of accessibility (no access to the full text)

- Studies that did not report any impact of landfill fires on the environment or human

- All articles that were not peer-reviewed

Quality control for papers reviewed

The search of databases was limited to only peer-reviewed articles that were published between 2017 and 2021 in reputable journals, including Elsevier, Journal of Environment and Earth Science, Asian Journal of Environment and Ecology, Applied Science and Environmental Management, etc. To ensure the academic rigors of the studies, the researcher also ensured that the articles were of good methodological soundness and quality [23].

Results and Discussion

Initially, 1,340 studies were retrieved by electronic database search. None were included in the manual search. After 349 remained the total yield. By the researcher screening abstract and titles, all irrelevant articles were removed, and the full text of the remaining 81 was assessed in a more detailed manner. Seventy-one of those numbers were excluded for various reasons like literature reviews, studies irrelevant to the topic, studies that did not investigate the impact of landfill fires. Consequently, only 10 remaining

studies were included in the review [24]. The search process is detailed in Figure 1.

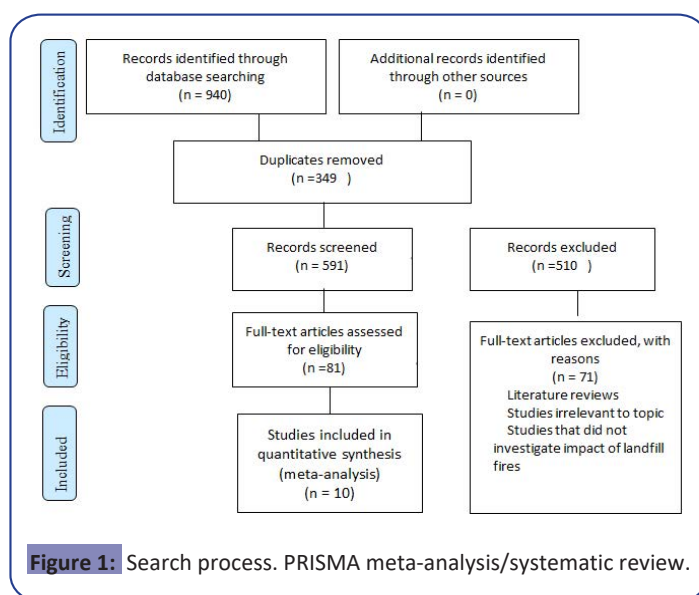


Figure 1: Search process. PRISMA meta-analysis/systematic review.

Characteristics of included articles

The sample size for each study varied. The studies were published between 2017 and 2021 in reputable journals. One of

the studies included children. Consequently, the general characteristics of the included studies are detailed in Table 1.

Table 1: Characteristics of studies included in the systematic review.

Author	Journal	Year of Publication
Adetona, et al.	Springer	2020
Aliu	Applied Science and environmental management	2021
Mazzucco, et al	BMJ Open Access Journal	2020
Tran, et al.	Asian Journal of Environment and Ecology	2019
Olawoye	Journal of Environment and Earth Science	2019
Kret, et al	Elsevier	2018
Yu, et al.	Elsevier	2018
Odonkor and Sallar	Heliyon	2021
Etea, et al.	Dove press	2021
Sing, et al.	Elsevier	2020

The purpose of this study was to systematically review and combine the evidence from multiple articles of the socio-economic, environmental and health impacts of fires at the Riverton city landfill [25-27]. Eight studies were identified and included in the review. Consequently, from the available evidence, the general finding from all eight articles is that landfill fires impact the environment and human health. In one of the studies, Adetona et al., found that residents living in a community adjacent to a large open landfill were found to have increased frequencies of neurological and musculoskeletal symptoms. Residence living in the community for more than 11 years had increased odds ($p < 0.05$) of daily occurrence of the tingling, numbness, whiteness of fingers (2.614), headaches (2.725), memory problem (2.869), cramps/tremor (2.748) and confusion (3.033) among other symptoms. The study found that these results indicate adverse health

impacts of chronic exposure to MSW combustion emission. Another study, Olawoye, presented robust evidence that several socio-economic, environmental, and health implications have arisen as a result of buildings located within a 200-500 m radius of a landfill. The study recommends proper monitoring and robust waste management strategy, social inclusion in waste management to militate against the devastating effects on human health and the environment. A qualitative study by Etea, et al. to the risk perceptions and experiences of residents living in Ginchi town near Aba-Semer municipal solid waste dumpsite in Ethiopia found compelling evidence from participants that humans' health and the environment is impacted by landfill fires. The author's details, design, target group, data collection, outcome measure and summary of results are detailed in Table 2 [28,29].

Table 2: Summary of studies used in review.

Study details	Study design	Target group, place and size	Data collection instrument	Outcome measure	Summary of results
Adetona, et al. (2020)	Cross-sectional	Residents living adjacent to a large open landfill in Lagos, Nigeria.	questionnaire	Participants views about exposure to combustion related emissions from an open landfill	Potentially increased risk of exposure to combustion related emissions from an open landfill is associated with increased frequencies of respiratory, neurological, and musculo skeletal symptoms.
Aliu (2021)	Cross-sectional	Dumpsites in Igando Alimoso area of Lagos Nigeria	Structured question-naire	Perception of solid waste management of dumpsites in Igando Alimoso area of Nigeria	Waste dumpsites constitute negative social, residential, environmental and health externalities to the
Mazzucco, et al. (2020)	longitudinal retrospective	A community living near the largest landfill plant in Sicily, Italy.	Institution records	Potential effect on pregnancies at different gestational ages by pollutants emitted from the landfill on fire.	Exposure to very preterm and very low birth weight among infants born to mothers exposed to the landfill fire emissions during conception or early pregnancy.
Tran, et al. (2019)	Quantitative	Participants living within 50 meters and those living beyond 250 meters of a dump site in Nigeria	questionnaire	Explore the impact of odor stemming from Da Phuoc landfill site on Surrounding areas.	Odor affects regions more than 7 km away from the dump site. The odor emanating from the MSW disposal site negatively affects the daily life of many residents.
Olawoye (2019)	quantitative	Olusosun community in Nigeria close to landfill	structured questionnaire	Implications of Residential Buildings in Proximate Distance to Landfill Site.	Several socio-economic, environmental and health implications arise such as proper monitoring and robust waste management strategy, social inclusion in waste management.
Ganesan (2017)	Cross-sectional study	Households near landfill sites and households in the city. Total sample size was 175. Located on the south-west coast of the Indian peninsula.	Questionnaire and interview		Subsurface spontaneous fires are not restricted to any landfill geometry, landfill type of operation, or type of waste. The addition of oxygen free gas can reduce the landfill temperature through water evaporation without promoting
Yu, et al. (2018)	cross-sectional study	Association between air pollutant and respiratory health of 951 children residing near a waste landfill in Northern China	questionnaire	association between air pollutant (AP) and respiratory health	oxidation. Children living adjacent to landfill sites were more likely to have deficient non-specific immunity and impaired lung function.
Odonkor and Sallar, 2021	Cross-sectional design.	The study was done in Accra (Figure 1), the national capital of Ghana	questionnaire	correlation of house hold waste management as well as their implications for public health	It is recommended that stakeholders and policy makers should focus on education for the citizenry on waste management behaviors.

Etea et al. 2021		Residents living in Ginchi town near Aba Semer municipal solid waste dumpsite in Ethiopia.	Interview and focus group discussions	Exploration of the risk perceptions and experiences of residents	All the participants perceived municipal solid waste open dumpsites as a risk to the environment and health.
Sing et al.,	A cross-sectional	Open dumping site and health risks to proximate communities in Mumbai, India	Interviews	Health effects of dumping site among nearby community members and identifying potential risk factors.	Result from suggest that exposure to the dumping site leads to a higher prevalence of respiratory illness

Plans of how to use the results

The outcome of this review will be incorporated in the main study that is currently being undertaken by the researcher to assess the socio-economic, environmental and health impact of fires at Riverton city landfill on the Kingston Metropolitan area, Jamaica. The findings are intended to strengthen the body of literature and assist in identifying gaps in the methodology of the available literature [30].

Limitations/challenges in the literature

This study has presented several limitations. Firstly, only a few studies met the search criteria as most of the articles on municipal solid waste or landfill fires are reviewed articles that would not contain the type of primary data required for this study [31,32]. Also, studies are mainly conducted on landfills in African or Asian countries, with little or no studies conducted in the Caribbean region or Jamaica.

Conclusion

In conclusion, the overall findings of the systematic review are that all the studies show compelling evidence to suggest that the environment and humans' health are negatively affected by fires at municipal landfills. Although the articles presented important scientific evidence about the impact of landfill fires, further studies should continue to assess the other impacts of landfill fires.

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