

Biomedical Waste Crisis and Post-Covid 19 Challenges: Mechanisms and Solutions

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Abstract

While modern healthcare and the pandemic have surely been taking a care on the economic and health concerning aspects of the world, a very underrated issue that has been on the rise lately is dealing with the constant stream of biomedical waste being churned out by the pharmacies, hospitals, clinics and patients alike. A light is to be shed on this issue and plausible ways to deal with it. The rapid review method was used in the study for quick analysis of articles and literature taken from a fixed time period to produce a quick review. Rapid review was chosen here as the main method because the field of covid-19 is ever evolving and quick, on-spot analysis is needed to keep with the latest research.

Keywords: Bioinspired Design; Bioengineering; Biomedical Waste; Covid-19; Waste Management.

Introduction

With the advancement of global health, global environmental health is facing an immense issue in the form of biomedical waste. 2 to 5 million, comprising of 4 million children perish to the failure in treatment of these wastes annually.¹ However, unlike general municipal waste, biomedical waste is an actual health issue, and the methods to deal with them have been released by the ministry of environment, forest and climate change in the form

of Management rules 2016 and Amendment rules 2018.^{2,3} While the covid 19 scene had challenged the global healthcare scene by pin pointing the lack of arrangements in facing an epidemic, various back-up plans had to be implemented. These included emergency isolation wards and home quarantine, causing a massive amount of biomedical waste to be generated, and as notified by Central Pollution Control Board reporting to the National Green Tribunal, it amounted to 101 metric tons. The figures of 500-800 gms of biomedical waster per bed generated in a hospital increased manifold to 2.5-5 kgs of waste produced daily.

A simple explanation of Biomedical waste in regards to Covid-19. This includes, but isn't limited to the waste products formed during the multiple processes experienced by a Covid-19 patient, such as screening, quarantine, treating the disease, post-treatment care at home, etc. An important criterion to note is that unless patients have contact with any sorts of solid waste, it is not accounted for as infectious waste and can be treated as per the

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guidelines provided by Social Waste Management Rules, 2016.⁴ Developing countries such as India have been facing a continuous issue of biomedical waste management. However, this changed in 2016 when the Ministry of Environment, Forest and Climate Change released guidelines for arrangement and management of Biomedical Waste by the Government of India have decided to segregate different sorts of biomedical waste through colour coding, further facilitated in 2018.^{5,6}

Objectives

The following are the objectives of the study:

- To discuss the cause of Biomedical waste generation.
- To correlate Covid-19 and Biomedical waste generation in the current times.
- Discussing steps taken by the government to curb this problem.
- Providing data analysis for the issues discussed in this paper.

Scope

The literature utilized for this paper has been collected from Web of Sciences for a period of 2019-2022 (Web of Science Core database) on 7th of September 2022. The process for collecting these articles was rapid review.

Methodology

The rapid review method was used here to collect data. The rapid review involves a quick analysis of articles and literature taken from a fixed time period to produce a quick review. Rapid review was chosen here as the main method because the field of covid-19 is ever evolving and quick, on-spot analysis is needed to keep with the latest research.

Inclusion: English language published articles on the specific field of research and keywords/phrases.

Exclusion: Literature other than peer-reviewed articles has been excluded.

The Searches Conducted on the Basis of Following Keywords/Phrases:

The field of biomedical waste disposal is specific yet vast, so the following phrases/words were used to search for articles.

- Covid 19 waste and removal
- Biomedical waste and covid 19
- Hospitals and covid 19 biomedical waste

- Biomedical techniques and covid-19 waste
- Biomaterials and covid-19 challenges
- Biodesign implementation and covid-19

Background Literature and Observations

Excessive spread of (SARC-Cov-2) in the global scenario has led to excessive biomedical wastage, hence posing a major issue to the environment and public health. Rather, the incorrect ways of waste disposal have rather led to an increment in the spread of SARS-Cov-2 virus. At the end of 2022, the biomedical wastage issue is bound to reach sky high numbers with an estimated 775.5 tonnes/d, hence proving the fact that the collection, separation and removal of biomedical waste are serious problems.⁷ This number however is not immune to the possible growth that may be caused due to the revival of the Covid pandemic. A very effective method to curb this flow of improper medical waste disposal is the implementation of a reverse logistical system. However, this system is yet to be developed, much less implemented. Hence the problem of an increase in disease spreading rates and the medical personnel getting infected are incrementing at an alarming rate.

A new mixed integer program capable of solving multiple problems in the field of reverse logistics network design in the case of an epidemic was suggested by Yu, Sun, Solvang & Zhao, (2020).⁸ The main goal of this program was to suggest and locate the most efficient spots for settlement of temporary institutions and providing transport for the same. A case study on the Covid outbreak in the Wuhan province of China was also presented along side to explain the functioning of the model. Despite newer strains emerging and causing the field of research to be highly unstable and unpredictable, this real world analysis and data might prove fruitful in devising an effective solution and Bio-medical waste management and disposal.

The covid-19 situation has managed to over complicate all previous conceptions about biomedical waste management. It challenges multiple previous notions, such as the percentage of infectious waste differing from the previously established 15%-20%. These astronomical numbers are further affected by the heaps of waste being poured out from various new sources such as home quarantine, new hospitals that are unaccounted for, emergency and temporary facilities, etc. Internationally acclaimed and recommended rules and necessities were being paid heed to while at the same time solving the various issues of Covid-19.

A whopping amount of problems concerning both public and private health as well as environmental issues are caused by biomedical wastes. Therefore, it is of paramount importance that such waste should be dealt with as safely as possible. This pandemic has already brought out and even widened the multiple issues previously existing in India regarding the disposal and treatment of biomedical waste. The sudden pandemic also led to a shortage in man power and also led to a lacking infrastructure. Therefore, to deal with these pertaining issues, various guidelines have been issued by the government, whereas the old ones have been updated to ensure they are better suited to the occasion.⁹

Various steps and guidelines have been provided to deal with the issue of biomedical waste and patient waste better. These involve, but are not limited to the usage of personal protective equipment, as well as using disinfectants on the same to make sure they are safe. It is also important to use recycled materials for these equipment and use biomedical waste for co-processing in cement kilns. However, to truly assess the impact and scope of the issue faced during the pandemic, we must analyse the data regarding the same after the pandemic.¹⁰

Various Aspects from India

A massive surge in the degree of production of biomedical waste as well as Plastic waste can be seen due the Corona virus pandemic. In especially developing countries, a very serious issue arising is that fact that unless proper methods of waste disposal be undertaken, the virus pandemic shall soon convert into a waster pandemic. There were rules regarding the disposal of biomedical waste management in India in 1998. A more formal and better explained set of rules was then laid out in 2016, which were further corrected and adapted to in 2018 and 2019.¹¹ India has followed the correct methods of waste as directed by Central Pulsation Control Board ever since the Coronavirus problem was designated as a pandemic in March, 2020. These were met by further revisions to modify the policies implemented in present time.¹²

It is crucial to realize and know the various factors governing the spread of the virus in the environment, along with the nature of infection and propagation. Important information to note is that the virus doesn't transmit from just one human to another, but is capable of spreading through fomites as well.¹³ Non living objects can still house coronavirus for over 9 days while maintaining an infectious state. This duration however can be

affected by temperatures over 30 degree Celcius.¹⁴ Some easy ways to deal with virus are common disinfectants that can harm it past its lipid envelope, UV radiation and heat both wet and moist. The virus is more than capable of staying in the air for durations over 3 hours and will still be able to infect new people. A new report by the World Health Organization dictates that aerosol generating procedures, which lead to droplets being formed in the air can also lead to airborne spreading of the disease and may be a major factor in spreading the disease. Many outdoor locations have also showed a combination of droplet transmission through cough along with this aerosol transmission, for example, the gyms.¹⁵

Challenges for Biomedical Waste due to COVID-19

The covid pandemic has been keeping the scientists and the government at their feet by bringing newer and newer problems daily.

Safe disposal of waste that may have been a result of home quarantine is also necessary. A part from that, waste formed in the new, temporary facilities, emergency hospitals and intensive care units also needs to be treated properly. Apart from that the dead bodies and burial needs to better managed as it challenges not just the physical safety of the patients but as well as the emotional/ mental wellbeing of the patients.

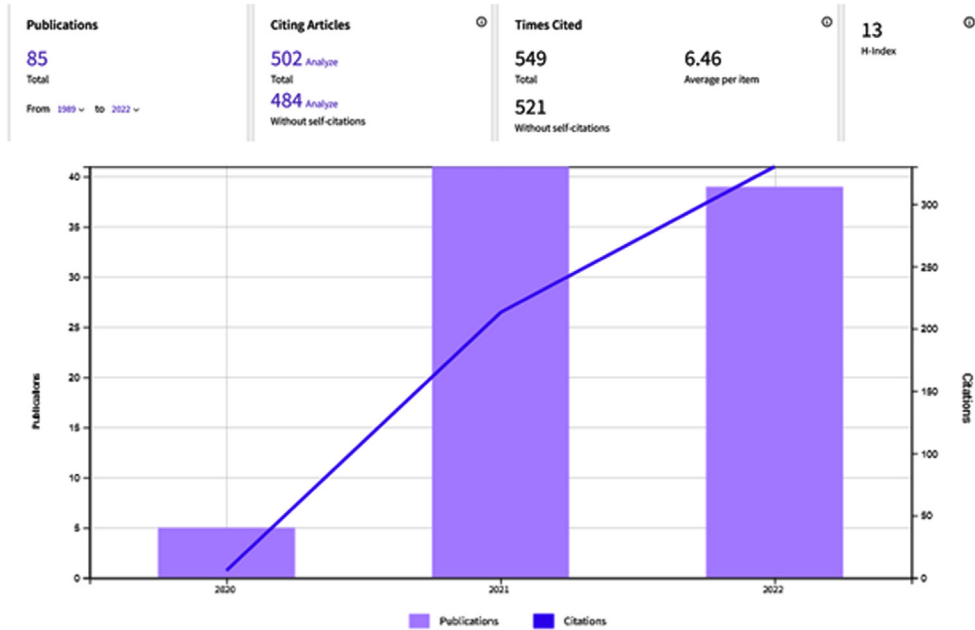
Materials added to water for simply washing medical products are having detrimental effects on the natural water bodies. These materials involve soaps, detergents, biocidal agents, etc.¹⁵ Now that most of the common public is also using these safety devices utilized only by professionals earlier, its important that proper disposal techniques should be taught to these non-professional, common people.^{16,17}

The Central Pollution Control Board of India has paid heed to all these demands and has decided to manage newer methodologies to treat this waste that is being generated through out the processes of checking, treatment and diagnosis of covid-19 patients.¹⁸ These methods use segregation of Covid-19 waste and regular waste into different bags, a different record of covid related waste and following all Bio Medical Waste disposal and management guidelines.^{19,20}

Data Analysis:

1. Covid-19 Waste and Removal

As in the graph here, for the key-phrase, Covid-19



waste and removal, there were 85 publications, a total of 502 citing articles which were cited for a grand total of 549 times.

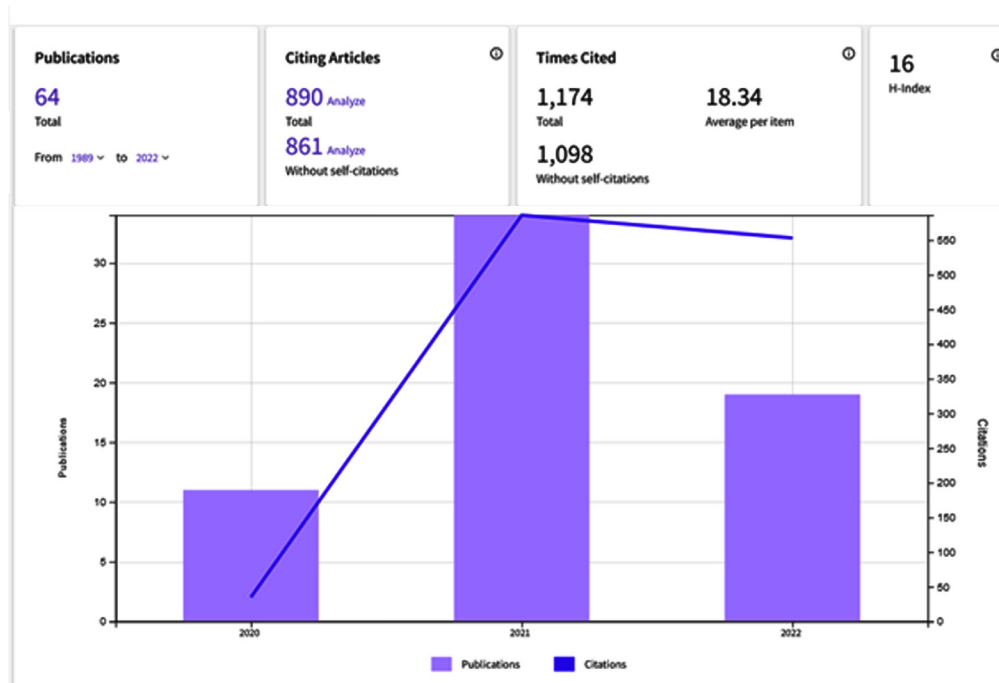
2. Biomedical Waste and Covid 19

The key phrase 'Biomedical waste and covid-19'

Biomedical waste and covid 19 (All Fields)

Time span: 1989-2022.

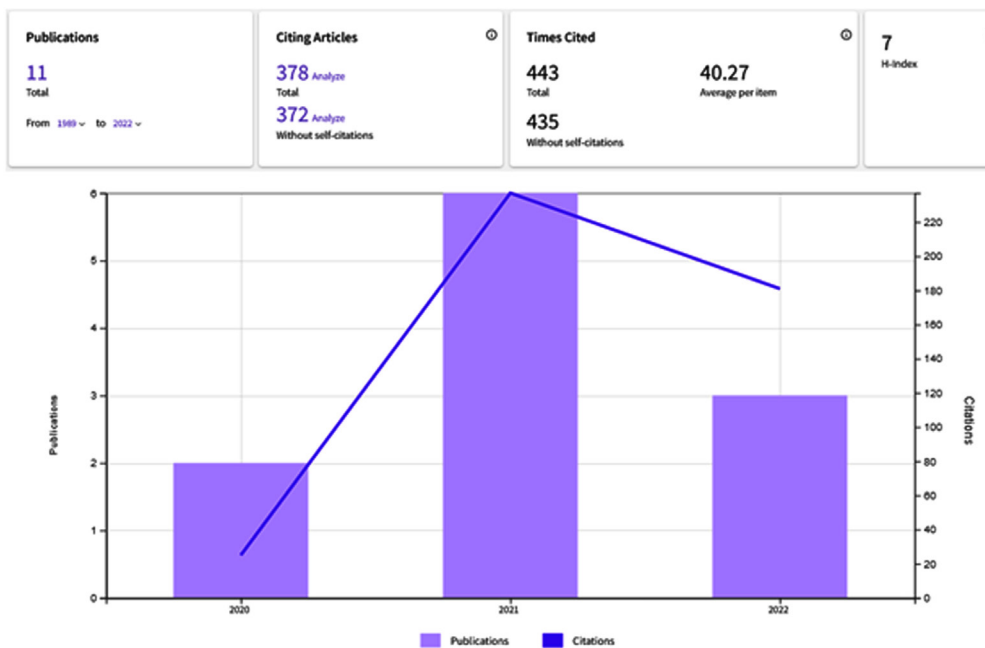
Results found	64
Sum of the times cited	1174
Average citations per item	18.34
h-index	16



amounted to 64 publications and 1174 citations, averaging 18.34 citations per item.

3. *Hospitals and Covid 19 Biomedical Waste*
 ‘Hospitals and covid 19 biomedical waste’ saw a

Hospitals and covid-19 biomedical waste (All fields)	
Time span: 1989-2022.	
Results found	11
Sum of the times cited	443
Average citations per item	40.27
H-index	7

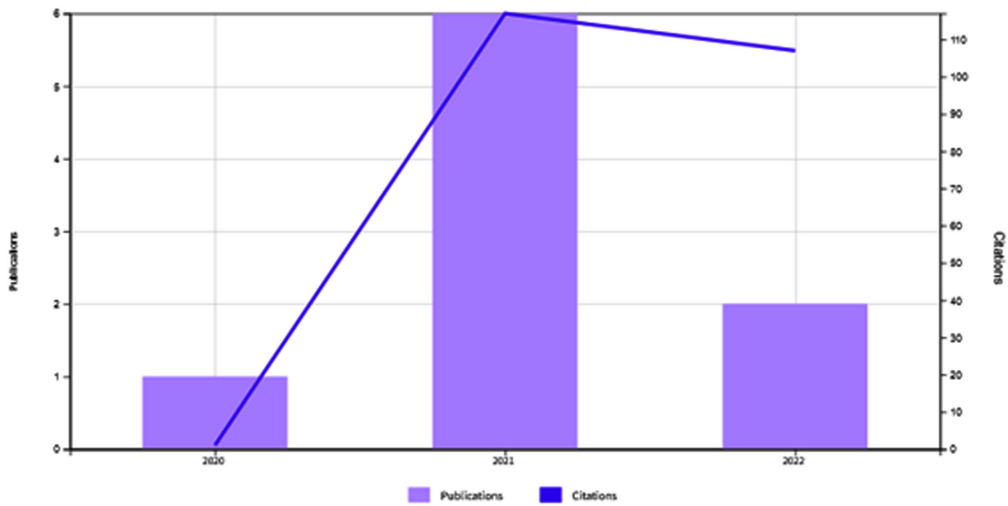


total of 40.27 citations per item spread across 11 total publications and 443 citations.

4. *Biomedical Techniques and Covid-19 Waste*
 9 publications were recorded for ‘Biomedical

Biomedical techniques and covid 19 waste (All Fields)	
Time span: 1989-2022.	
Results found	9
Sum of the times cited	225
Average citations per item	25
H-index	5

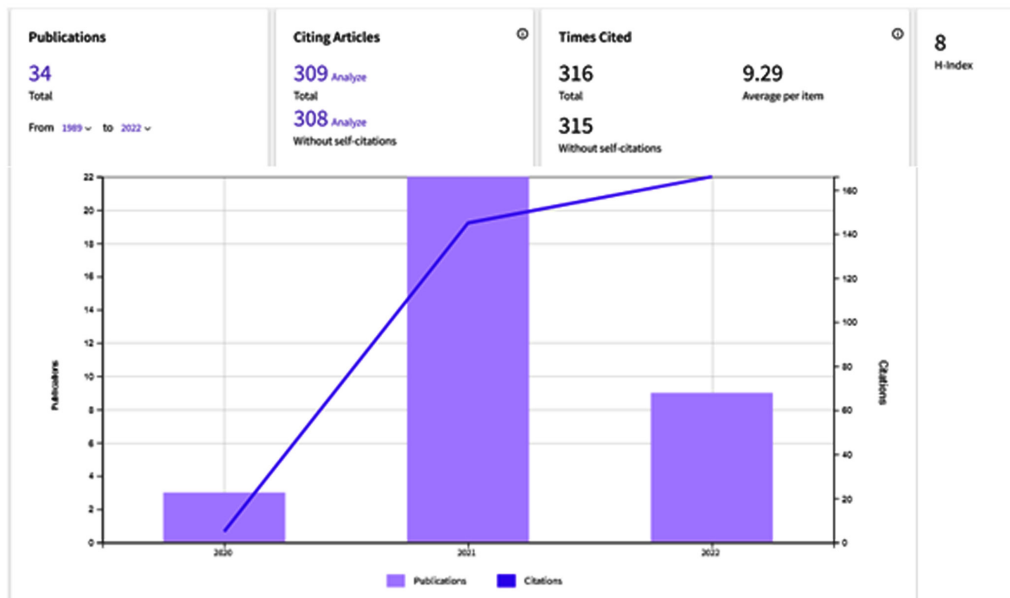




techniques and covid-19 waste’ with 25 average citations per item, thus leading to 225 citations.

5. Biomaterials and Covid 19 Challenges

For ‘Biomaterials and covid 19 challenges’, there



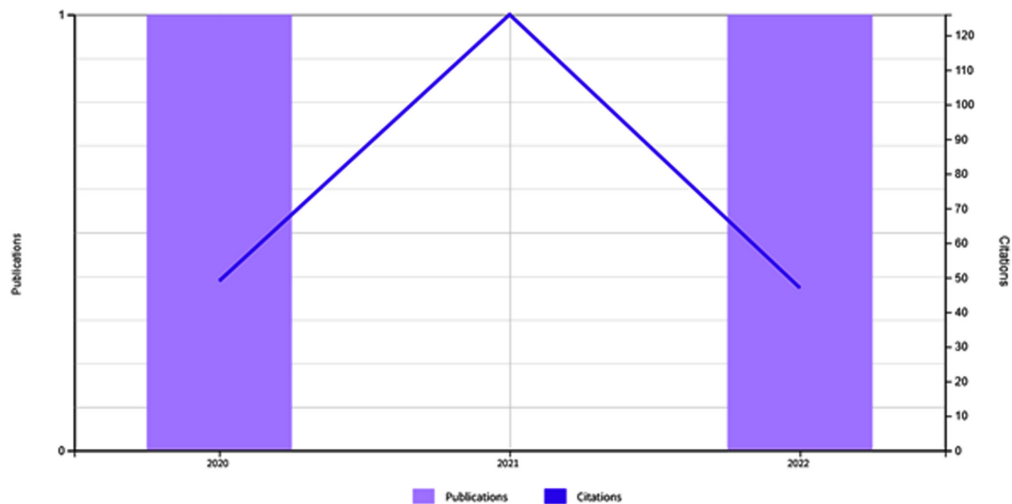
were 34 publications which were cited 316 times, averaging at 9.29 citations for each item.

for the phrase ‘biodesign implementation and covid-19’, there were also 222 citing articles which means it averaged at 111 citations per article.

6. Biodesign Implementation and Covid-19

There have been a total of 2 publications found





Discussion

The Covid-19 pandemic has brought into general notice various problems like the huge amounts of Plastic Waste and Bio Medical Waste generated. This also involves the changes that had to be brought in to accommodate the various situations experienced due to covid-19, along with the new ways of waste disposal and the amount of Bio medical waste that can be treated. However, certain issues such as the treatment of Carbon based Bio Medical Wastes and the amount of waste left around by them were positively affected.

Bio medical waste related to Covid-19 can be treated very easily through a simple step the ability to separate solid waste from its bio medical waste counterpart. End of the day, it is simply waste created due to an infectious disease, therefore providing guidelines and spreading awareness about this waste caused by Covid-19 will be paramount in helping to stop it. These will help check and reduce the amount of toxic waste generated from both hospitals, as well as patients in home quarantine. End of the day, Bio medical Waste is a threat to all health and a major environmental concern.

Conclusion

As a final take away, it is important to note that biomedical waste in itself, alongside the disease is a serious health concern. Now only does it cause toxicity, but it also may facilitate spreading of infectious microbes. The capability of this virus to spread is highly potent due to its contagious etiological agent. Hence, the government became aware of the various harms inconsistent treatment of biomedical waste may bring about, and have

along with AIIMS, Delhi and other such prestigious organizations come up with various guidelines to curb the spread of any more biomedical waste and stop the flow of this virus. In the end, the rules must be strictly followed for full effect of stopping waste propagation and curbing the virus spread.

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