



## Research Paper

### Retrospective research study on bio-medical waste generated in correlation to patients treated from a tertiary care COVID-19 hospital in Maharashtra

Prerana Dalvi<sup>1\*</sup> and Doss Prakash S.<sup>2</sup>

<sup>1</sup>Faculty of Social Sciences, M. G. M. University, Aurangabad, Maharashtra, India

<sup>2</sup>Department of Community PT, M. G. M. Institute of Physiotherapy, Aurangabad, Maharashtra, India

\*Corresponding author email: [preranawish@gmail.com](mailto:preranawish@gmail.com)

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**Abstract:** The COVID-19 pandemic outbreak posed greater challenges to all the sectors across the globe. The entire world is still battling with the unprecedented pandemic crisis since December 2019. Containing the spread of COVID-19 has been a multifaceted challenging task, as the disease progress with fresh waves and new variants. The pandemic has also paved new research thrust areas apart from medical frontiers. The most relevant research would be impact of COVID 19 on the environment, and climate. The only positive side of these COVID-19 lockdown measures was noticed on the environmental perspective, particularly in regard to short-term environmental improvement in air quality by drastic reduction in the air pollution, green house gas emissions, nitrogen oxide emissions, and carbon dioxide emissions all across the globe and contrarily, the COVID-19 pandemic sparked a huge surge in bio-medical waste generation. Hence a retrospective research study was conducted to find the correlation of bio-

medical waste generated and patients who were treated in a tertiary care COVID-19 hospital in Maharashtra from 2019 to 2021.

**Keywords:** COVID-19, Bio Medical Waste, Environment, Pollution, Personal Protective Equipments, Waste management

#### Introduction:

The COVID-19 pandemic outbreak posed greater challenges to all the sectors across the globe. The European Union nations requested the Health Environment and Research Agenda (HERA) for Europe project to recognize the thrust research areas impacting environment, climate and health due to the unprecedented COVID-19. (Barouki *et. al.*, 2021).

The COVID-19 disease and the community response to the pandemic have brought significant behavioral and societal changes that will be remaining long as the new-normal and this may have long term

deleterious health effects and environment. The mechanism of these dynamic interactions between the disease and environment needs special focus and attention. COVID-19 recovery plans are currently researched, deliberated, discussed, and implemented but the environmental health impact plans are not clearly foreseen and charted out. During the first and second wave of COVID-19; all countries shut their borders and imposed stringent lock down measures, to curb the spread of COVID-19. Containing and mitigating the spread and infection of the coronavirus is the first priority of governments, with concerted efforts to shore up public health systems and unprecedented social and economic response measures.

These measures created a mixed impact on the environment. The positive side of these lockdown measures was noticed on the environmental perspective and it has attracted attention, particularly with regard to short-term environmental improvement in air quality in several cities in India, Europe, China and Brazil. CPCB, 2020, Dasgupta and Srikanth, 2020, Sharma et. al., 2020). There was a drastic reduction in the air pollution, green house gas emissions, Nitrogen Oxide emissions, and carbon dioxide emissions all across the globe (Chen et. al., 2020, Dutheil et. al., 2020) and contrarily, the COVID-19 pandemic sparked a surge in bio-medical waste pollution. The infectious medical waste in Hubei Province of People's Republic of China (PRC) increased by 600% from 40 tons per day to 240 tons per day in January 2020, during the COVID-19 outbreak. This over-burdened the existing medical transport and waste

disposal infrastructure around the hospitals (Shi and Zheng, 2020). Soon other countries faced similar challenges in dealing with the overwhelmed biomedical waste and its impact on the environment (ADB, 2020)

On the other side, the new normal COVID Appropriate Behavior (CAB) after the unlocking measures has paved way for considerable societal changes and behaviors; particularly wearing of face masks, hand gloves, increased utility of Personal Protective Equipment (PPE) kits in health care sector.

PPE was widely used across the globe to protect humans against the dreadly virus. China for instance, increased the production of face mask by 450% in just one month (Hiemstra et. al., 2021). It is estimated that 129 billion face masks and 65 billion gloves are used monthly across the globe (Prata et. al., 2020). These figures risk are growing substantially as countries around the world confront the coronavirus pandemic. All these attributed to an increase of COVID 19-litter polluting our environment. The COVID 19 litter consists of single-use (usually latex) gloves and single-use face masks, consisting of rubber strings and mostly polypropylene fabric. Fadare and Okoffo 2020) With a lifespan of 450 years, the face masks used to combat COVID-19 pandemic is an ecological time bomb which can have a lasting environmental consequences to our planet. While this pandemic crisis is still unfolding across the world, and will continue to evolve for some more time with new strains and variants, empirical evidences on the association between COVID-19 and environmental stressors are still emerging.

The sudden increase in COVID-19 Associated Waste (CAW) will possibly increase the potential risk of distressing the environment. Few countries have started to devise new stringent plans and policies as they are struggling to overcome the waste-disaster. In light of the very limited literature on the efficient bio-medical waste management of CAW, there is also an imperative demand to have efficient strategies to protect the environment further by CAW. (Kothari *et al.*, 2021). Hence it is very much clear that, COVID-19 has a long-lasting impact on the environmental health field and has open new research perspectives and policy needs with focus on environmental stressors. This original retrospective research article spotlight the highlights of efficient and well-organized COVID-19 bio-medical waste management in a dedicated COVID-19 specialty hospital based in Aurangabad, Maharashtra state of India in a prospective manner.

### Materials and Methods:

A retrospective study was conducted in a tertiary care super-specialty hospital by analyzing the bio-medical waste generated during 2019, 2020 and 2021 in respect to the total number of patients treated in the hospital during these three years. The tertiary care hospital has total 935 patient beds including beds in intensive care units and super-specialty departments. During the first wave (2020) and second wave (2021) of COVID-19, the hospital closed the non-emergency medical specialities temporarily to cater the emergency needs of COVID-19 patients. The hospital was converted into a modal and dedicated COVID-19 care hospital with 550 oxygen

beds with oxygen and 105 Intensive Care Beds (ICU) beds. The data of the bio-medical waste generated was obtained from the quality control cell of the hospital. The outpatient and inpatient statistics of the hospital was obtained from the medical record office of the hospital. Both the data were obtained after taking necessary permission from the hospital authorities. The ethical approval was obtained from the Institutional Ethical Committee for conducting this study. Data collected was analyzed using the Statistical Package for Social Sciences (SPSS) (version 22). The data was summarized using mean, frequency and percentages. The results were presented in tables and pie charts.

### Results:

The bio-medical wastes in the hospital are collected in four distinct color codes – Yellow, Red, White and Blue. The human anatomical waste, solid waste, discarded medicine, microbiology and clinical laboratory waste including used mask (including Triple layer mask, N95 mask etc), head cover/cap, shoe-cover, disposable linen Gown, PPE, non-plastic or semi-plastic gowns are collected in yellow bins with double-layer protection. The contaminated wastes are collected in red bins. The waste sharps are collected in white bins. The glass wastes are collected in blue bins. The Maharashtra Pollution Control Board (MPCB), which published draft guidelines for treatment facilities, healthcare establishments (HCEs) and labs, general public, and self-quarantined patients, has selected ‘yellow’ as the colour code for all Covid-19 waste. The year wise bio-medical waste in respect to

code and category wise and patient statistics in shown in the Table-  
**Table : 1 – Details of Bio-Medical Waste generated & total no of patients treated in the year 2019, 2020, 2021**

Code	Category	Year			Difference (2019-20)	Year on Year (%)	Difference (2019-21)	Year on Year (%)
		2019	2020	2021				
Yellow (Including COVID Waste)	Human Anatomical waste	983	916	836	67	7.31	147	17.58
	Solid waste	2045	1924	1746	121	6.29	299	17.12
	Discarded Medicine	32	33.4	40	-1.4	-4.19	-8	-20.00
	Micorbiology & clinical lab waste	41	47.8	41.5	-6.8	-14.23	-0.5	-1.20
Red	Contaminated waste	3531	3128	2306	403	12.88	1225	53.12
White	Waste sharps	270	252	316	18	7.14	-46	-14.56
Blue	Glass	1171	1080	911	91	8.43	260	28.54
	Total Biomedical Waste in kgs	8073	7381	6196	692	9.38	1877	30.29
	OPD	311950	102970	217893	208980	202.95	94057	43.17
	IPD	206652	76735	82291	129917	169.31	124361	151.12

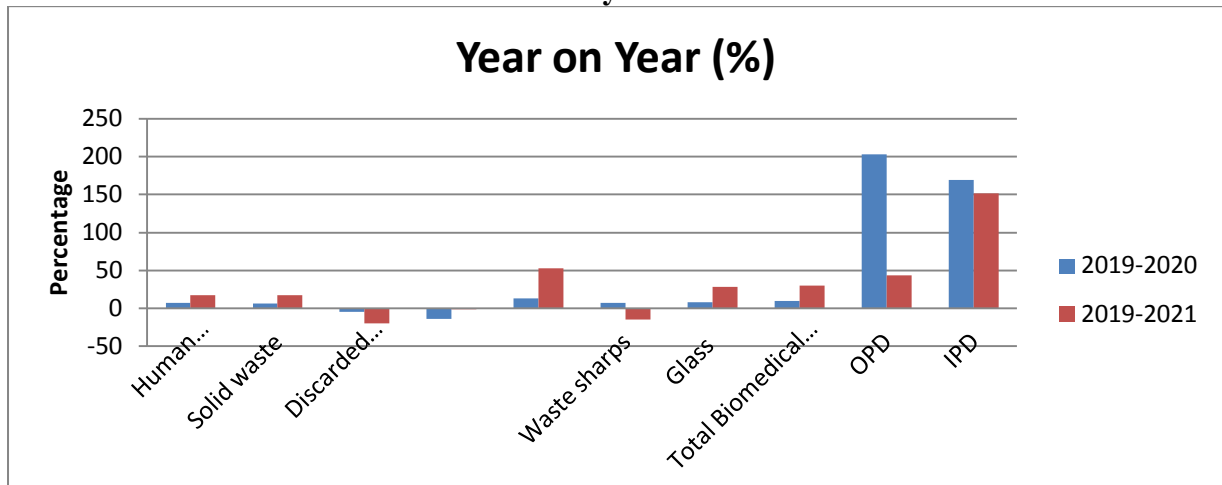
There was rate of increase of discarded medicine by 4.19% from year 2019 to 2020 and by 20% from year 2019 to 2021. (Table–1) On the same way, there was rate of increase of Micorbiology & clinical lab waste by 14.23% from year 2019 to 2020 and by 1.2% from year 2019 to 2021. (Table-1) Whereas rate of increase was inversely consistent with the hospital services of OPD i.e. by 202.95 % from year 2019 to 2020 and by 43.17% from year 2019 to 2021, similarly of IPD ie by 169.3% from year 2019 to 2020 and by 151.12% from year 2019 to 2021. (Table - 1)

There was rate of decrease of total biomedical waste by 9.38% from year 2019 to 2020 and by 30.29% from year 2019 to 2021. Whereas rate of increase

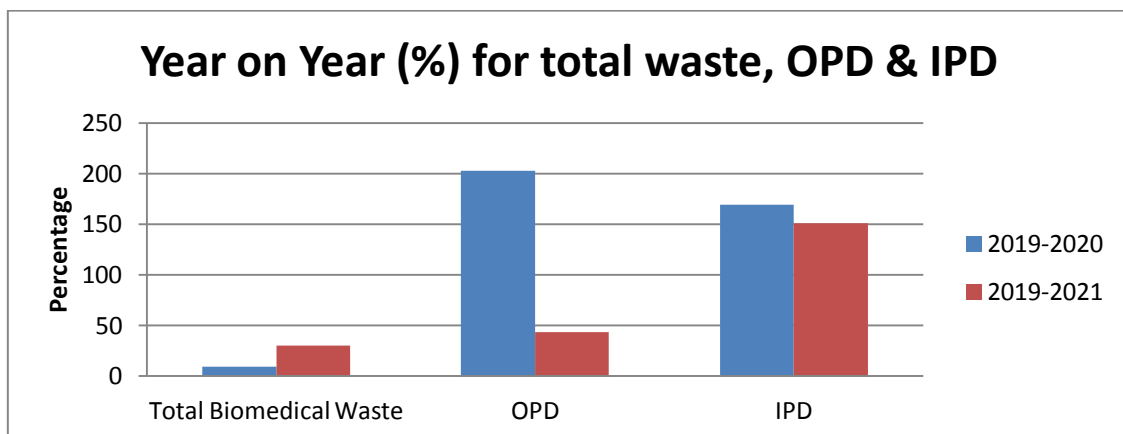
was consistent with the hospital services of OPD i.e. by 202.95 % from year 2019 to 2020 and by 43.17% from year 2019 to 2021, similarly of IPD ie by 169.3% from year 2019 to 2020 and by 151.12% from year 2019 to 2021.

The total biomedical waste generated in the year 2019 was 8073 kilograms for the outpatient strength of 3,11,950 patients and inpatient strength of 2,06,652 patients. Whereas, in 2020, the outpatient strength was 1,02,970 patients and inpatient strength was 76,735 patients but the total biomedical waste generated was 7381. Further, in 2021, the outpatient strength was 2,17,893 patients and inpatient strength was 82,291 patients but the total biomedical waste generated was 6196. (Figure 2 & Figure 3)

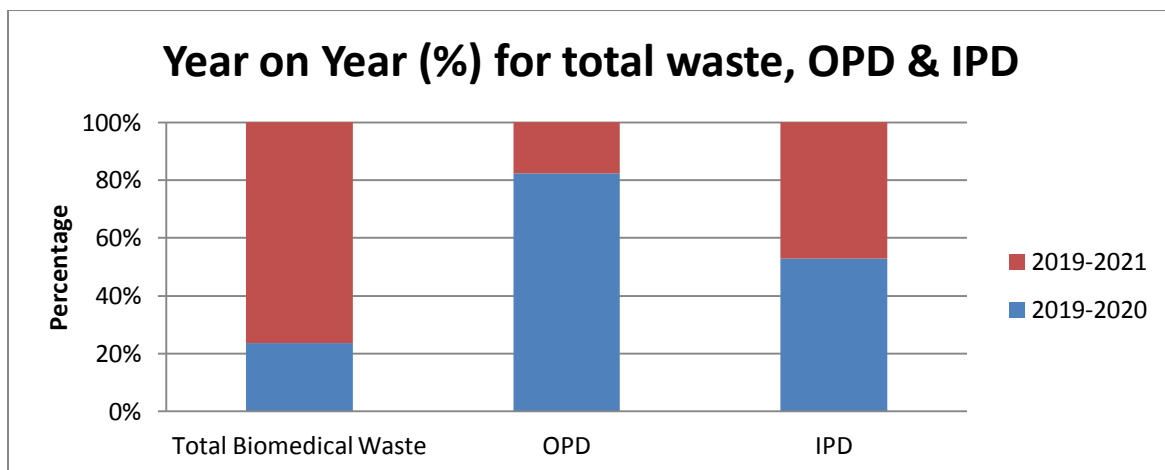
**Figure : 1 – Graphical representation of category wise BMW generation & patients treated in OPD & IPD in the year 2019-2020 & 2019 - 2021**



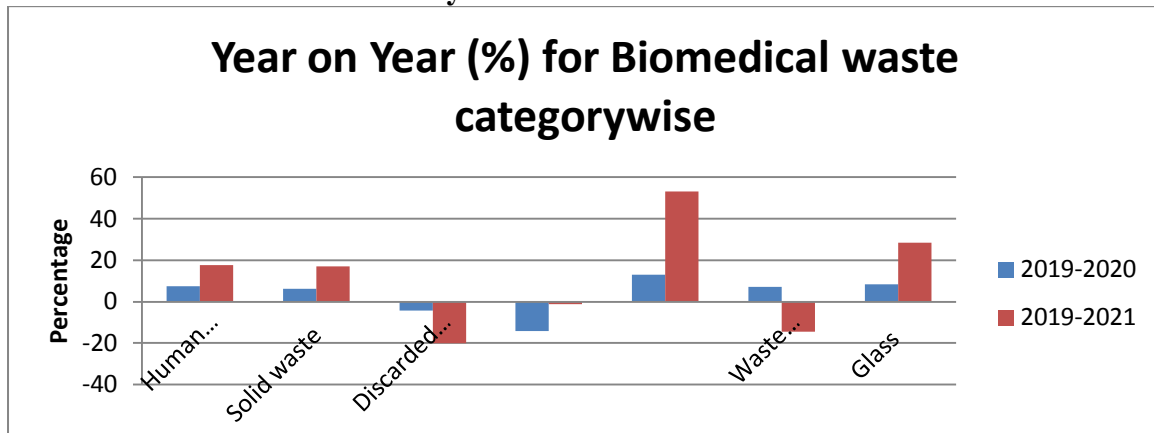
**Figure : 2 – Multiple bar graphical representation of total BMW generation & patients treated in OPD & IPD in the year 2019-2020 & 2019 – 2021**



**Figure : 3 Proportional bar graph representation of total BMW generation & patients treated in OPD & IPD in the year 2019-2020 & 2019 – 2021**

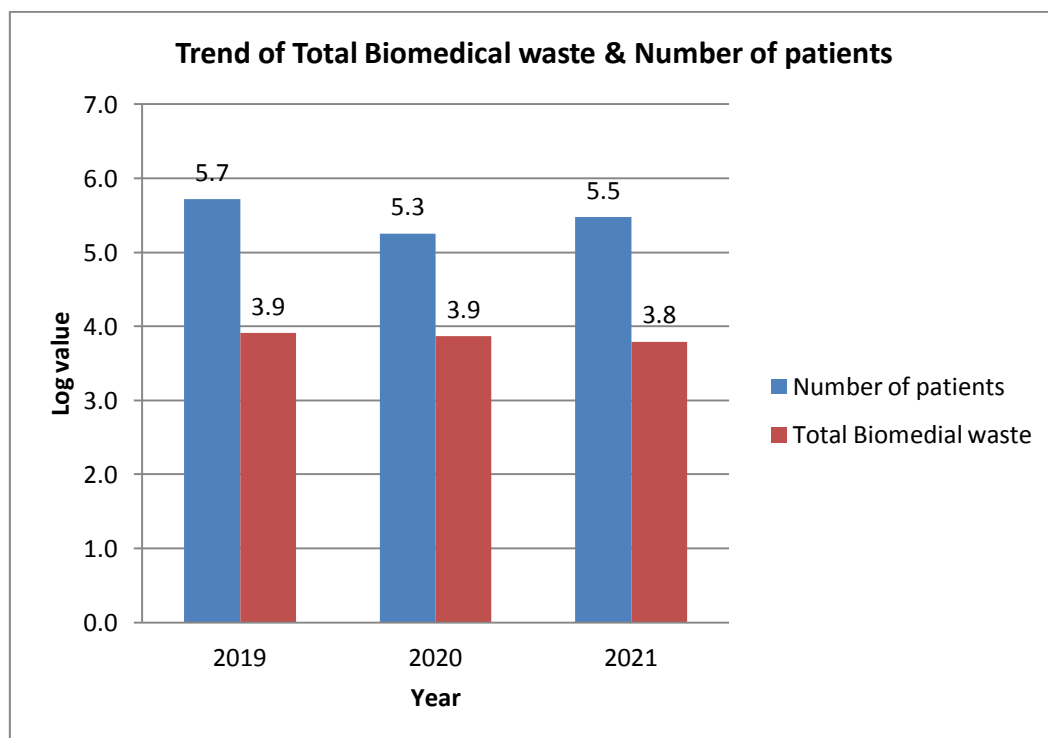


**Figure: 04 – Multiple bar graphical representation of category wise BMW generation in the year 2019-2020 & 2019 - 2021**



The actual values of biomedical waste and patients treated are converted to logarithm value for the convenience of comparison purpose. It was observed that, that number of patients was varied (declined) from 2019 to 2021; however the biomedical waste remains stagnant during the same period. This clearly signifies the COVID-19 clinical management generates considerable amount of bio-medical waste stressing the existing environmental system and paving way for potential environment stressors to the globe. The trend of this values of biomedical waste and patients treated are shown in Figure: 5.

**Figure 5: Trend showing the total BMW generated and total no of patients treated in the year 2019 to 2021**



### Discussion:

The challenges faced in combating COVID-19 are multidimensional all across the globe, which includes treating the severely affected COVID-19 patients in intensive care units, providing optimal care to patients with mild to moderate symptoms in hospitals and quarantine centres, and preventing the spread of pandemic by lockdown measures and imposing strict COVID-19 Appropriate Behavior (CAB) in the community. Eventually, the negative environmental impact due to COVID-19 is gaining attention as the new catastrophe erupts as COVID garbage crisis.

The United Nations Environment Program estimated last year that hospitals and health centers across the world produced about 3.4 kgs (7.5 pounds) of COVID-related bio-medical waste per patient per day worldwide. The first and second waves of COVID-19 pandemic was fought with range of personal protective equipment (PPE) made from plastics which played crucial roles in protecting people from the corona virus disease. There was also a growing concern over the increase in single-use plastics (SUPs) including gloves, PPE medical suits, masks, hand sanitizer bottles, takeout plastics, food and polyethylene goods packages, and medical test kits. The covid waste in this pandemic has wrecked the global healthcare systems and also the environment. (Benson et. al., 2021 Vanapalli et. al., 2021)

Further, tons of single-use PPE used by health care workers and the front line warriors are being discarded daily which are mostly made from non-woven materials including polymeric substances such as polypropylene. Also, gloves are made from several materials, including chloroethene polymers, neoprene, and vinyl. These plastic products could be categorized as macro- and mesoplastics, which can enter the environment through

poor waste management or improper discharge into the marine and terrestrial ecosystems (Jeyasanta 2020). To deal with this unprecedented bio-medical waste crisis, the State and Central Governments of India have initiated and enforced various stringent measures based on the guidelines brought out by WHO, MoH&FW, ICMR, CDC and other concerned agencies in addition to existing practices under BMW Management Rules, 2016 (Ministry of Environment, Forest and Climate Change, New Delhi 2020)

Our retrospective study concluded that BMW generated in yellow category during 2020 and 2021 in the hospital was 2921 and 2663 kgs respectively. The total number of patients (OPD & IPD) treated in these two years were 179705 & 300184 in 2020 and 2021 respectively. Contrarily, the total yellow category BMW generated in 2019 was 3101 for a total of 518602 patients. This clearly concludes that though the general patient load decreased drastically by 97.06% from 2019 to 2020, the BMW generated difference was only 5.97% between these two years. This clearly indicates the volume of BMW generated in a typical healthcare centre due to COVID pandemic. All these exponential increase in BMW was segregated at the point of generation using double-layered foot operated collection bins marked as COVID-19 waste. The (inner and outer) surface of containers/bins/trolleys used for storage of COVID-19 waste was disinfected with 1% sodium hypochlorite solution daily. Designated nodal officer (Quality Control team) for biomedical waste management provided appropriate training to employees handling COVID-19 BMW such as Hand hygiene, respiratory etiquettes, social distancing, use of appropriate PPE, etc. via videos and demonstration in local vernacular language. All the COVID-19 BMW was transported to the Common Biomedical

Waste Treatment Facility (CBWTF) authorized by the district administration. India has very stringent guidelines for onsite segregation of the BMW generated and its storing, transporting, and disposing in adherence to the biomedical waste rules framed by the ministry under the Government of India (Ministry of Environment, Forest, and Climate Change 2019). The BMW waste from hospital should be transported in a designated closed vehicle that is equipped with the global positioning system tracker. The BMW in the CBWTFs is then treated, sterilized, and sent for recycling, incineration, or land filling based on the waste category. The entire qualitative process and quantitative data on the BMW generation and disposal is accurately documented and reported to the state pollution control board. Violating these strict guidelines by hospitals / clinics and disposal facilities will subject them to penalties (Chand, 2021). Despite stringent rules and liability, the country reports a high degree of non-adherence to these guidelines.

The COVID-19 pandemic scenario led to an unexpected generation of high BMW from the hospitals, testing laboratories, and quarantine centers. Estimating the exact amount of BMW is challenging, although a study suggested the increment in BMW generation in this pandemic has risen as high as six-fold in comparison to the pre-pandemic situation. This increment in the volume and quantity places a high threat to the environment. A lack of authentic and sufficient data on BMW waste generation during COVID-19 and waste disposal exaggerates the problem further. Adding to this surge of hospital BMW, the impact of stringent CAB and lockdown measures with stay-at-home policies have added to intensification of single-use products and panic buying which led to thwarting efforts to reduce

environmental pollution (Samuel Asumadu and Asantewaa Owusu 2020).

The potential rampant dumping of COVID-19 waste by common public, open burning and incineration could affect air quality and health outcomes due to the exposure to toxins (WHO 2020). Thus, there exists a huge challenge of disposing unusual waste sustainably without polluting the environment with available waste facilities while reducing air pollution protecting the environment.

The COVID-19 pandemic has triggered a zero-waste approach in members of European Union nations to recycle the COVID-19 BMW which are scientifically and medically recommended so that there can be a declining of GHG emissions attributed to toxic waste disposal and incineration techniques (Samuel Asumadu and Asantewaa Owusu 2020). The zero-waste approach includes “the conservation of all resources by means of responsible production, consumption, reuse and recovery of products, packaging and materials with less burning, and with no discharges to land, water or air that threaten the environment or human”.

### **Conclusion:**

The COVID-19 surge with two waves and new variants highly impact the economic development and health outcomes of all the countries, also there is an imperative global call for waste management from households, medical facilities and the COVID-19 toxic waste to be treated as an essential public service. This will in effect mitigate the potential threats of COVID-19 pandemic on environmental sustainability and health outcomes. COVID-19 has exposed the world to numerous environmental threats —attributable to unsustainable use of single-use plastics. Owing to the global adoption of personal protective equipment such as face masks, future research should aim at developing biodegradable and environmentally

friendly protective gears including face masks, gloves, overalls, among others, to accelerate the agenda towards achieving sustainable production and consumption while reducing environmental costs. The post-pandemic crisis offers us valuable lessons that BMW before the pandemic cannot be continued as usual but it requires structural adjustments, hence drawing attention to the importance of transitioning from linear economy to a circular economy.

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