



## Review Paper

# Arising Challenges From Single-use Plastics and Personal Protective Equipment Through COVID-19 Pandemic in Waste Management System in Developing Countries



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## ABSTRACT

COVID-19 pandemic has led to lifestyle changes. One of the consequences of these changes is seen in the management of municipal solid waste. Management of single-use plastics and personal protective equipment (PPE) as one of the common solid waste in the period is one of the important challenges in waste management. This research was conducted by studying the articles related to the COVID-19 pandemic, plastic waste and PPE. The articles were selected based on a specific search protocol and selection criteria:

Because of inhabiting regulations for recycling, almost all produced waste was landfilled during early months of the COVID-19 pandemic. During a short while, developed countries started coping with waste-originated issues thank to their appropriate infrastructure. On the other hand, single-use plastics and unsafe disposed PPE has made health and economic problems in developing and low-middle income countries. There is an urgent need to make some corrections in waste management systems as well as public education to minimize the adverse effects of COVID-19 in developing countries.

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### 1. Introduction

**S**ince the very beginning of 2020, the world has been facing a newly-arrived issue, the COVID-19 pandemic. No doubt, dealing with COVID-19 and its related problems is the main health and economic challenge in almost all countries [1]. Most of the countries have experienced some challenges in personal protective equipment (PPE) supplying for medical staffs and general population [2].

For a three-month period, a number of outdoor activities became delayed or banned in many countries. The lockdown of cities caused some environmentally beneficial effects; they led to a significant decrease in inter and intra departures which, consequently caused a reduce in air and noise pollution. Likewise, limitation of industrial activities resulted in a great reduction of NO<sub>2</sub> and SO<sub>2</sub> emission. In addition, the concentration of CO<sub>2</sub> was dropped to the less extent after world war II [3]. Besides, the weakened tourism industry led to clean beaches and water bodies. In addition, canceled flights around the world declined air pollution [4].

On the other hand, COVID-19 pandemic made some environmental problems in some cases. The main environment-related section coped with numerous problems was the waste management industry [5]. Due to mandated social distancing and lockdown of cities, people had to use packed food in a large extent which caused unprecedented high production and usage of single use plastics (SUPs) throughout the world. Generally, 25%, 42%, and 22% of disposed plastics were incinerated, imperfectly treated and recycled, respectively [6]. Since COVID 19 pandemic, almost all recycling facilities were recessed, and the wastes were recycled through landfills. Additionally, the nature of discarded materials had been changed. PPE made up a big fraction of disposed waste [7]. Regarding health-oriented guidelines, all people may use 2-3 facemasks and 4-6 gloves daily (25-40 grams) increase in assumed infectious waste production per capita [8]. Furthermore, recycling programs

and facilities accompanied with reusable waste returning schemes have been suspended in many countries [9]. All these alterations caused some challenges in both medical and municipal waste management systems.

Along with the alteration carried out in municipal waste management, medical waste mangers have become shocked by the COVID-19 pandemic. Their guidelines do not work, and there is no integrated policy to manage lots of medical wastes. They had to assume that all produced waste in hospitals and other medical centers are infectious waste. Furthermore, the amount of used PPE at the health provider centers had been vastly increased [10]. Some countries immediately adapted some strategies but the others have been faced with serious problems, especially in less developed countries.

In this perspective, we addressed some unprecedented dire consequences of COVID-19 on medical and municipal waste management systems with a focus on the production of excessive amount of SUPs and PPE.

### 2. Materials and Methods

This review study was conducted in 2022. In this study, articles related to waste management due to the COVID-19 pandemic were reviewed. The articles were searched at [Scopus](#), [PubMed](#), and [Web of Science](#) databases using a search protocol and some keywords including COVID-19, waste management, PPE, and plastic. After searching, the final articles were screened using defined criteria ([Figure 1](#)). Screening steps were separately performed by all authors and finally the selected articles were reviewed.

### 3. Results

The results showed that plastic consumption increased sharply during the COVID-19 pandemic. The use of plastic by citizens increased for two reasons. The first one is the use of PPE against the virus and the second one is the increased use of SUPs caused by pandemic-induced lifestyle changes. This change in consumption has accordingly led to a change in the quantity and com-

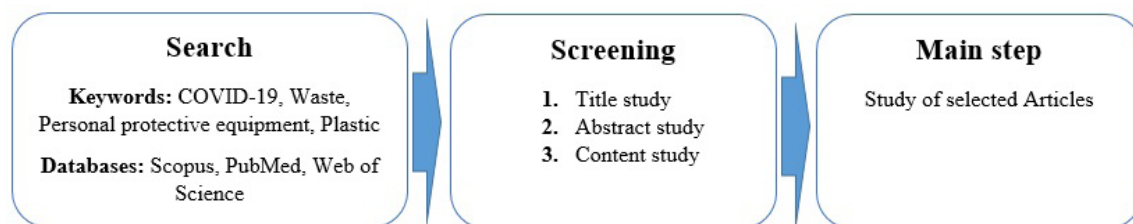


Figure 1. Study process

position of municipal solid waste. Also, the municipal solid waste management have been affected by the COVID-19, which is described below.

### Medical waste management during COVID-19 pandemic

The production of PPEs has been dramatically increasing since February 2020, especially in health care facility providers. In Hubei Province, China, the amount of medical waste (infectious and noninfectious) has increased up to about 5 folds (i.e. from 40 to 270 metric tons per day) [11]. In a short time, the use of facemasks by people became regulated in more than 50 countries, leading to a dramatic increase in production of facemask and other protective equipment [12].

By emerging coronavirus, there was no integrated guideline in order to separate different types of wastes in the medicals centers, and eventually all produced waste in these centers were assumed to be biohazard waste and disposed under serious rules [13]. In developed countries, there is suitable infrastructures including incinerators and sanitary landfills for disposing the medical biohazards [14]. In these countries, after a short time, several guidelines were issued to manage medical waste by utilizing their present facilities. For example, in China, all medical discarded items should be disinfected before disposing. Additionally, in the UK, medical wastes are temporarily stored, and incinerated ashes are allowed to be landfilled. However, all these attempts cannot guarantee the potential of secondary infections [11]. On the other hand, in several developing countries, mismanagement of the wastes generated in healthcare centers and PPE have resulted in high-risk conditions [9]. For example, about 1.5 billion facemasks are being used every two days only in African countries, where there is no sufficient solution for proper management, especially during a pandemic [9].

Besides, the amount of disinfected waste has significantly increased, and the disinfecting facilities are used for a longer time. In this condition, the operators might be exposed with several risk factors induced by the products like BTEX [15].

The main problem is arisen when the correct procedure for treating medical waste is neglected. For instance, in some countries, all wastes produced in health centers and hospitals are being gathered alongside medical waste and they are eventually burned or landfilled incorrectly. The inappropriate buried waste can pose a significant threat for general public [9].

### Municipal waste management challenges appeared by COVID-19 pandemic

The amount of produced non-infected waste was also increased during the COVID-19 period in which the people should remain at houses. For example, the waste production in China has increased by about 30% during the COVID-19 epidemic. As far as economic is concerned, suspension of recycling efforts because of transmission risk of coronavirus, causes a great financial loss. In addition, during COVID-19 pandemic, costumers would rather purchase the products derived from virgin plastics, which have environmental and economic adverse impacts.

In addition, because of weak infrastructure, policy-makers cannot adopt an integrated solution to cope with the hazards originated from COVID-19 crisis. Moreover, people in these countries are not well-trained regarding dispose of PPE. The best and most applicable way to dispose facemasks and gloves is to put and seal the equipment in one or two bags. Unfortunately, it is not properly advertised for the protective strategies in other countries. It is also reported that PPE has been thrown away in living environment like streets. Also, all compounds of household waste have been disposed along possibly infected masks and gloves. Under these circumstances, waste and service workers who have to pick up the PPE are at the risk of secondary contamination with coronavirus.

Waste workers were concerned at the beginning of COVID-19. While it is recommended that before disposal all PPE should be sealed in the bags, but the majority of people dispose the facemasks without sealing. People who are dealing with facemask like waste workers are highly at risk of COVID-19. More importantly, due to close contact with the infected people as well as their contaminated clothes, the family members of these individuals are more likely to be infected by the virus. Furthermore, in developing countries, the wastes containing PPE are being collected in worn bins or open dump, which leads to release leachate and spread the masks and gloves by a light wind. These conditions can increase potential risk of the diseases for public people, health and waste workers as well as the environment.

Also, waste pickers can easily have access to landfill facilities, where a huge amount of contaminated waste has been collected, thereby increasing the risk of secondary infection. Also, they sometimes recycle the used masks and sell back them in an illegal way that threaten the public health [16]. Recently, in Nigeria, access to

**Table 1.** Solid waste management affected by increased PPE and SUPs consumption

Challenges	Solutions
<ul style="list-style-type: none"> <li>• Consumption of PPEs has been dramatically increasing since February 2020, especially in health care facilities</li> <li>• High rates of PPE and SUPs littering in public areas</li> <li>• Increasing microplastic resources in the environment</li> <li>• Lack of guidelines and equipment for proper disposal of this waste in some developing countries</li> <li>• Not segregating of this waste from common waste as well as municipal solid waste in health care centers in some developing countries</li> <li>• Increased risk of the virus transmission among waste management staff and waste pickers due to lack of occupational health in some developing countries</li> </ul>	<ul style="list-style-type: none"> <li>• Establish the proper guidelines</li> <li>• Cooperation of international institutions and developed countries with developing countries for better management of this waste</li> <li>• Effective disinfection of PPE and SUPs by physical and chemical methods</li> <li>• To separate the PPE and SUPs from other wastes by educating citizens and increasing equipment</li> <li>• To educate citizens in order to avoid or properly dispose the wastes</li> <li>• Increase plastic waste recycling capacity</li> <li>• Limitation in access of waste pickers to bins and landfill sites</li> <li>• Multinational collaboration and sharing data</li> </ul>

landfills has been limited to the waste pickers in order to reduce the risk of cross-contamination by the people. On the other hand, the waste pickers are still doing the risky activities in landfill places and throughout the cities in many countries [17].

In order to reduce the virus transmission, health policy makers decided to delay or ban any separating activities in waste cycle in several countries. This approach, eventually led to an increase in the volume of buried waste, especially the SUPs [5]. Landfilling the SUPs without any sorting process will eventually increase the used space in suburb areas of cities, where the space is being limited during time. In addition, landfilling of the SUPs will increase the volume of emitting GHGs in long term [18].

### Possible solutions for handling the challenges

Given the challenges of increased PPE and SUPs consumption, some solutions have been proposed to control the situation and prevent environmental consequences. These solutions can be categorized in two general groups, named medical waste management and municipal waste management.

#### Medical waste management systems

Administrators in developing countries must establish proper guidelines to prevent the spreading of facemasks, especially in health care centers. They can also work in cooperation with experts from other parts of the world to share their experience in different aspects of this issue during the COVID-19 pandemic.

Physical or chemical based disinfectants should be utilized to reduce the load of virus in medical waste. For example, high-temperature combustion, high-temperature pyrolysis technique and chlorine-based treatment methods can be used to disinfect the wastes before landfilling

[19]. Sanitation workers should be severely monitored and enforced to wear proper PPE including masks and gloves in all steps of waste management process.

#### Municipal waste management systems

Based on existing guideline in developed countries, SUPs are being recycled under some specific circumstances. For example, all plastic bottles are returned to the consumption cycle, if decontamination is implemented using proper disinfectants [20].

Additionally, people should be encouraged to use the bio-based plastics or naturally compostable ones. Bio-based plastics can provide our needs in medicine, PPE production as well as other health-related equipment. Meanwhile, the proportion of these plastics are very low (less than 2%). On the other hand, due to low cost, the fossil fuel-based plastics are more popular than bio-based counterparts. To impose some tax-oriented rules on people who use SUPs and plastic bags might make a significant change in the issue [5].

As far as waste workers and waste pickers are concerned, it should be advised that all PPEs should be discarded in the sealed bags. In addition, in some public places and buildings, the bins for PPE should be provided. PPE can be also separated from other types of waste during COVID-19 pandemic to ensure that waste pickers are not exposed to contaminated PPE.

Waste pickers should be also restricted in the access to landfills by provision of some applicable measures. These measures can be accompanied with development of safer waste management efforts such as improvement of landfill facilities and incineration or decontaminating devices [9].

As dealing with COVID 19 needs cooperation between officials and people, all the measures in proper and safe

management of waste are applicable, if all policymakers, retailers and dwellers step forward and work in cooperation with each other. Multinational collaboration, sharing data and information, and virtual international meetings can also be effective to adopt new scenarios and strategies. The challenges of PPE and SUPs in solid waste management and the solutions to address them have been summarized in [Table 1](#).

## 4. Conclusion

There are some challenges in both medical and municipal waste management systems during COVID-19 crisis, especially in developing and low-middle income countries. Lack of reliable guidelines results in a big problem and challenges. On the other hand, insufficient technical and financial infrastructures to cope with the remarkable volume of PPE and SUPs wastes lead to a considerable risk for people and workers of these countries. To deal with these problems, policymakers should work in collaboration with each other and be consulted by international counterparts. Furthermore, some suitable disposal methods of PPE should be advised to the general public in order to improve their knowledge and behavior in this regard.

## Ethical Considerations

### Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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### Authors' contributions

All authors equally contributed to prepare this project.

### Conflict of interest

The authors declare no competing interests.

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