

Plastic Pollution by COVID-19 Pandemic: An Urge for Sustainable Approaches to Protect the Environment

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Abstract

COVID-19 pandemic has created a prolonged impact globally and destructed the life all over the world. The necessary use of personal protective equipments, masks, gloves and other plastic products has to some extent reduced transmission of virus. However, the impact of plastic waste generated worldwide due to the pandemic has affected the environment globally. The coronavirus disease (COVID-19) has destructed and altered every part of life and environment globally. Potential impacts on environment are seen due to the transmission of virus as well as a slowdown in economic activities as lockdown prevails. Increased biomedical waste, improper usage and disposal of surgical masks, disinfectants, gloves, and increasing plastics wastes from domestic households continuously endangers environment. Not only it has an impact on the environment, but also deteriorates human health in the future. Global environmental sustainability is necessitated to overcome the plastic pollution problem and facilitate strategies to recycle and reuse plastics products. This review highlights the influence of COVID-19 on wastes generated by plastic products along with environmental challenges and repercussions. Also, measures to combat the plastic pollution problem have to be implemented for future protection and safety of the environment.

Keywords: COVID-19, Deteriorates, Environmental sustainability, Plastic Pollution, Strategies

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INTRODUCTION

COVID-19 pandemic, an outbreak originating from Hunan seafood market in China, was considered as an emergency by World Health Organization (WHO) within few months after its origin¹. COVID-19 popularly referred as (SARS-CoV-2), is a contagious and easily transmissible disease causing severe lung infections and acute chronic diseases in individuals^{2,3}. Different studies by researchers have reported the emergence of the virus however significant insights into the immediate source of transmission is not yet configured⁴. As of 14 May, 2021, 160,813,869 confirmed cases and 3,339,002 deaths have been reported by WHO globally⁵. Fig. 1 depicts the prevalence of active cases worldwide as observed by Our World in Data⁶. Studies have reported the transmission of virus via direct contact and through drops formed by cough, sneezing or talk^{2,7}. SARS-CoV-2 mostly infects the respiratory tract because of over expression of angiotensin-converting

enzyme-2 (ACE-2) in epithelial cells. ACE-2 acts as a receptor for attaching to SARS-CoV-2 spike protein 'S' thereby increasing the chance of infection in humans⁸. Also, emission of NO₂ and particulate matter (PM_{2.5}) in air increases chance of viral infection as it causes breathing problems in individuals⁹. The common symptoms observed in individuals prone to the virus are fever, body ache, cough, sore throat, breathing problems and even diarrhoea⁷. Acute severe respiratory diseases and mortalities occur in patients that have severe infection of virus^{7,10}.

To knock down the epidemic curve, different governments have taken various measures including implementation of partial or complete lockdown¹¹, along with treatment facilities to protect the hospital and healthcare workers. Though second highest populous country globally with poor health care systems, India managed to control the transmission of virus by imposing social lockdown at the earliest in

Daily new confirmed COVID-19 cases per million people

Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.

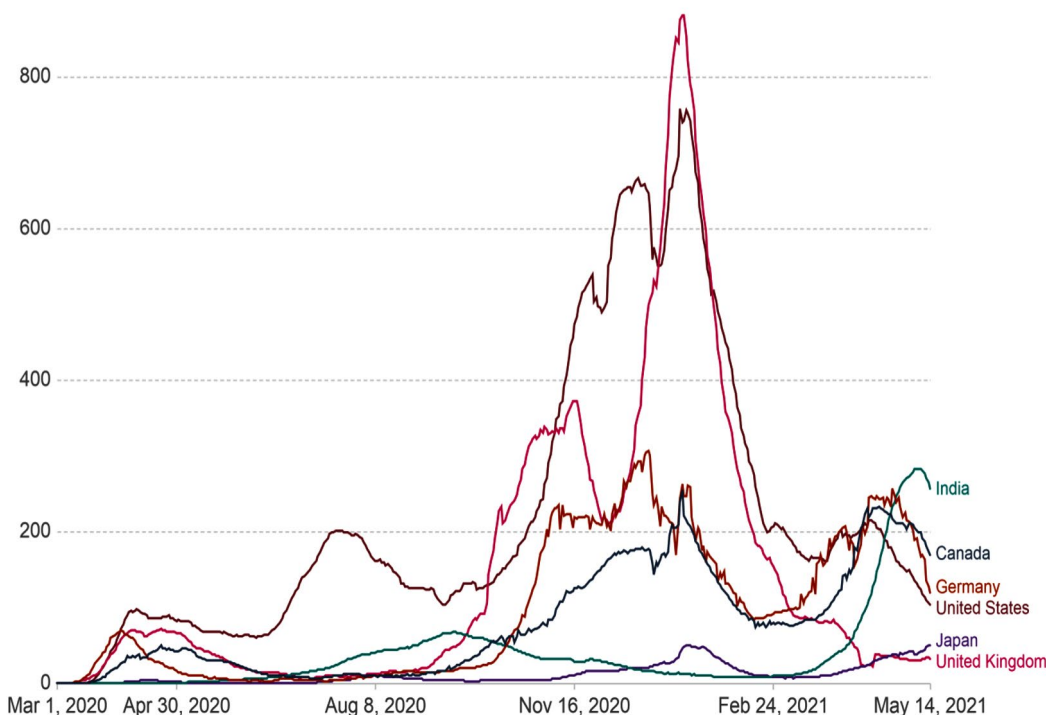


Fig. 1. Confirmed COVID-19 cases globally as on May 14, 2021⁶.

March, 2020¹². It has also initiated the usage of personal protective equipment (PPEs), gloves, surgical masks, sanitizers and plastic packaging to procure and contain the spread of novel coronavirus^{13,14}. The major outcome of what started as a health disorder has now become an environmental problem owing to the emerging plastic waste generated from the pandemic and its prevalence in the ecosystem¹⁵. Various scientists have observed the persistence of COVID-19 virus on plastic surfaces for a longer time that can disrupt the health of individuals and environment^{3,16}. The implications posed by the pandemic have been underrated largely on the ecological front and less attention on environmental health problems is paid by governmental agencies¹⁷.

Unique to the current scenario, this review provides an outlook on deterioration that has occurred due to COVID-19 on management of plastic wastes. The review highlights implications of COVID-19 on plastic production as well as probable consequences of plastic waste generated by COVID-19 on environment. Also the article provides possible strategies and future recommendations to control and manage plastic in post-pandemic era.

Plastic Residues Produced from COVID-19 Tests and their Fate on Environment

Starting the occurrence of COVID-19 virus, several organizations and agencies have recommended the use of prompt plastic products and packaging materials to control transmission of virus. However, scientific community is worried on monitoring and combating plastic waste residues generated by COVID-19 pandemic. Most of the plastic residues are produced from RT-PCR tests of which approximating 97% of total plastic waste is incinerated to reduce hazardous chemicals from leaching in environment¹⁸. According to the reports by¹⁸, around 15439 tonnes of plastic wastes have been generated until August 2020. Globally, the amount of plastic residues from different continents is Asia (9600 tonnes), Europe (2200 tonnes), South America (560 tonnes), North America (2500 tonnes), Africa (270 tonnes) and Oceania (200 tonnes). The countries with most amounts of plastic wastes include China (38%), Russia (7%), United States (15%), India (6.4%), Germany (1.9%), Italy (1.6%), United Kingdom

(3%), Spain (1.6%) and Turkey (1.2%)¹⁸. Of all the plastic waste, 90% contribute to polypropylene, 8% to polyester and 1.7% to polyethylene¹⁸. Different plastic sources identified from COVID-19 tests include plastic swab, falcon tubes, plastic tip, plastic pipettes, buffer plastic bottles, aerosol plastic barrier tips, 96-well PCR plastic plate, and optical plastic plate and eppendorf plastic tubes. Therefore, each test estimates to around 37g of plastic residue that is left out in the environment¹⁸.

In today's scenario, disposal of plastic wastes generated from COVID-19 depends largely on its nature, whether it is classified as biohazardous or non-biohazardous. Biohazardous waste is mostly incinerated emitting various toxic chemicals that pollute the environment¹⁹ whereas non-biohazardous waste usually ends up in landfill sites thereby being exposed to wild animals and birds. The burning of biohazardous waste also causes air pollution thereby increasing particulate matter in air and increasing the chance of COVID-19 infection and other respiratory disorders⁸. The pollution caused by these plastic residues has many different biological influences in the assemblage specific levels of ecosystem. Plastic residues disintegrating into microplastics affect the marine plants while causing harm to the physical characteristics and soil biota²⁰. Especially because of the microplastics small size, the particles could be easily consumed or collected in the brain, or nerves, and also in the circulatory system of the creatures which causes many adverse effects²¹. Sub-deadly impacts include damage of the sensitivity, impairing reproduction capability, damage of mobility, reduced growth and body condition, lack of ability to escape from the predators²². Marine mammals like dolphins and whales are known to ingest majority amount of microplastic debris²³. Many scientists have examined microplastic consumption by microbiota like zooplankton²⁴, marine isopod—*Idotea emarginata*, *Calanus helgolandicus*; *Daphnia magna*; Amphipod *Orchestoidea tuberculata*²⁵. Adversative health effects can decrease country's efficiency and waged proficiency with harmful influence on public and economic characteristics.

Impacts of COVID-19 Biomedical Waste on Plastic Pollution

Before the emergence of COVID-19

pandemic, management and control of plastic waste was considered as a major environmental issue owing to disruption in terrestrial and marine environment^{26,27}. As plastic waste existing was an undeniable problem, emergence of COVID-19 has threatened the waste management regulatory as well as the environment. Temporary shutdown of restaurants, shopping complexes, stores and other commercial centres have reduced the transmission of the virus but also altered our living habits thereby creating waste management problems²⁸. Most of the individuals have shifted to the plastic packaged good including foods, PPE kits, gloves, and face masks along with disposal utensils that have created a havoc in the environment²⁹. An increase in online purchase causing more packaged goods and utilization of personal protective equipment (PPE) by hospital staff and health care workers have polluted aquatic environment³⁰. A survey in South Korea demonstrated an increase in online food purchasing and daily essentials by around 92% and 44% respectively³¹.

The tremendous use of personal protective equipments, including gloves, face masks³², and gowns³³, are usually made of polymeric materials including polypropylene (PP), polyethylene (PE)³⁴ and polyethylene terephthalate (PET). These polymeric materials have adverse effects on the terrestrial and aquatic environment³⁵. An increase in biomedical waste from different laboratory testing could also account for a substantial proportion of plastic pollution in environment^{36,37}. Fig. 2 depicts the plastic waste generation due to COVID-19 pandemic.

Not only does the plastic waste cause pollution to the ecosystem, their fragmentation into smaller microplastics and nanoplastics have detrimental effects on aquatic flora and fauna, soil microorganisms and public³⁸. Upon littering into the terrestrial and marine ecosystem, plastic responds differently and causes adverse impact on organisms of specific environment. The plastic waste along with deteriorating the organisms, also causes negative impacts on biodiversity and human health³⁹. Moreover, plastic surfaces act as great environment for the growth and proliferation of microorganisms including the COVID-19 virus that could cause infection in large amount of population. Also, plastic littered in open oceans and water bodies act as home for vectors of

zoonotic disorders including dengue by *Aedes* spp. threatening the population⁴⁰. The loss of faith in people due to unpackaged products can cause resurgence of single-use plastics and pollute the environment³⁰. Rise in demand of pharmaceutical products including medicines, blister packs, bottles and other products from hospitals and healthcare facilities have drastic impact on plastic waste generation¹.

Environmental Challenges from COVID-19 Plastic Waste Generation

Although the COVID-19 pandemic has generated huge tonnes of plastic pollution, but the nationwide lockdown to decrease transmission of virus has also benefitted many sectors that must be highlighted for revival of ecosystem⁴¹. For instance, following lockdown energy consumption declined considerably in India, China, USA and Italy⁴². Also, drastic reduction in coal and gas consumption was observed in China, Europe, North America and allied countries⁴³. Ozone concentrations in atmosphere also increased substantially because of decrease in nitrous oxide contents at ground level⁴⁴. Similarly, lockdown also helped in improving water quality of some Indian rivers including reduction in turbidity, increase in dissolved oxygen and lower levels of biological oxygen demand in river Ganga⁴⁵. Biodiversity and wildlife have benefitted from the lockdown due to reduced exploitation of natural resources by mankind⁴⁶. Despite enormous positive effects on environment created by COVID-19 lockdown, the world still faces disruption owing to plastic pollution. Various international agencies and regulatory authorities have been established to procure and address the detrimental effects of plastic pollution in environment⁴⁷. The perceived threat due to pandemic has undervalued existing plastic pollution problem to a great extent. COVID-19 pandemic has positive and negative consequences on environment as depicted in Table 1.

The plastic litter generated from different usable products as well as personal protective equipments (PPE) gets collected at different sewage drainage systems and dump yards, inducing blockage and percolation along with repercussions on agricultural productivity⁵⁸. Not only are they accumulated by disposal, but also inappropriate environmental conditions including

wind, storm and water runoff paves way for the biomedical equipments to flow in rivers, streams and lakes⁵⁹. Not only does plastic waste pollute the environment, but the virus adhering to the plastic can mutate and cause transmission to large population affecting the safety of the people⁶⁰. Plastic serves as a vector for spread of pathogenic bacteria and other contaminants that cause detrimental effects on aquatic species and soil microorganisms⁶¹. Most of the marine organisms mistake the smaller plastic fragments for prey and

ingest them as food resulting in toxic effect²⁴. Fig. 3 demonstrates possible effects of plastic pollution on environment.

Different plastic waste management processes including incineration generate huge amounts of pollutants released in the atmosphere. These small pollutants mix with the air and cause health hazards to the ecosystem and alter the biodiversity⁶². Moreover, different health disorders such as respiratory diseases, immunological diseases, cancer, and other disorders also cause

Table 1. Negative and positive aspects of COVID-19 on environment

Positive Effect	Negative Effect
Improved outdoor air ⁴⁸	Decrease in indoor air quality ⁴⁹
Less noise pollution ⁵⁰	Increase in biomedical waste ⁵¹
Decrease in deforestation ⁵²	Increase ecological risk to environment ⁵³
Decrease in greenhouse gas emissions ⁵⁴	Increase in incineration and land filling ⁵⁵
Less household food waste generation ⁵⁶	Increased disinfection with hazardous chemicals ⁵⁷

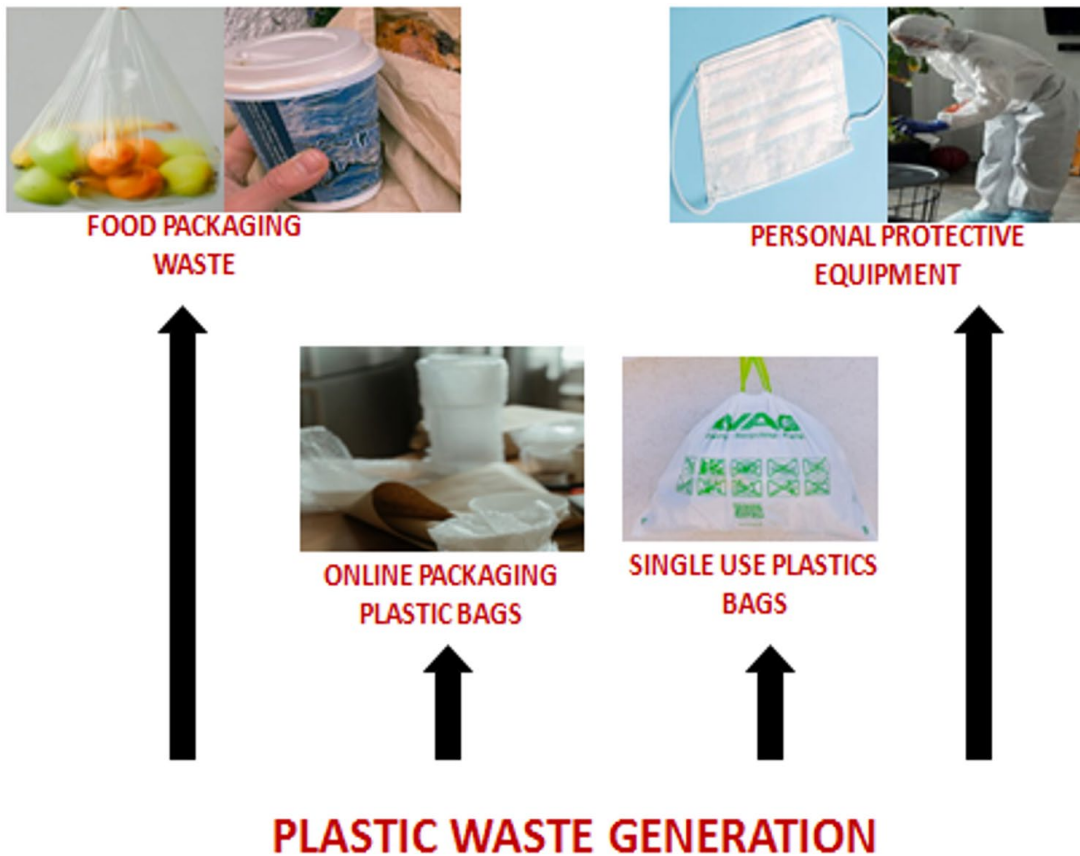


Fig. 2. Plastic waste produced from COVID-19 pandemic.

impact on human health⁶³. Exposure of harmful gases in atmosphere by burning of plastic waste causes release of toxic pollutants in soil that cause biological alterations and disrupt the biodiversity⁶⁴. Moreover, different waste recycling activities and management of plastic have come to a halt after the emergence of COVID-19 pandemic^{55,65}. Lack of innovation in deferring new management protocols during the pandemic and subsequent increase in plastic pollution has disrupted marine ecosystem, terrestrial environment and agricultural biodiversity. Enforcement of sustainable measures and standard procedures are necessitated to overcome the plastic pollution on a global scale.

Sustainable Measures and Recommendations to Combat Plastic Waste

COVID-19 pandemic has been prioritised in today's scenario as compared to impact of plastic

pollution on environment¹³. The impacts generated by the pandemic should be utilized to build a better future and society by combating plastic pollution⁶⁶. Proper management of plastic waste along with sterilization and disinfection is necessary to contain the spread of transmission and reduce the pollution in the environment. Waste management is important for reducing domestic and medical waste production and require proper guidelines to apply during pandemic to control plastic waste⁶⁷. Some plausible measures for sustainability of environment are proposed such as (Fig. 4).

Disinfecting PPE and medical waste

Treatment of waste using disinfection techniques, including ultraviolet, and ozone utilization can provide a sustainable approach for waste treatment. High amounts of waste necessitate incineration process that uses high temperature to kill pathogenic microbes residing

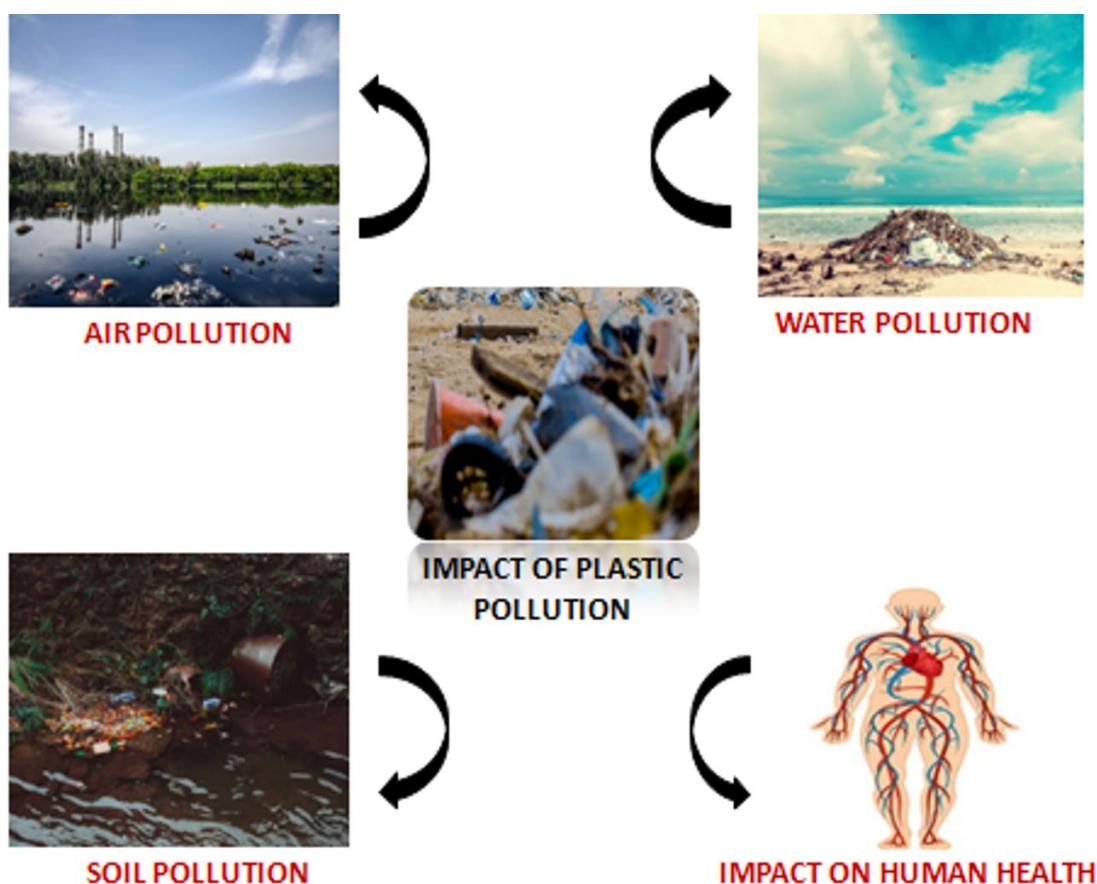


Fig. 3. Impact of plastic pollution on the environment.

on the surface of plastics. If the amount of waste is less in concentration, chemical disinfectants or high temperature steam is more suitable⁶⁸. Recycling technology could accelerate reuse of PPE kits and reduce the plastic pollution⁶⁹. Various decontamination methods for recycling and reuse of PPE and N95 masks can be facilitated⁷⁰.

Implementing sustainable safety measures in delivery goods

Proper mitigation strategies while delivery of goods and reusable plastic and grocery bags encourages less waste generation. Paper boxes and cardboard facilitates less emission of plastic waste and also eliminates toxic pollutants from contaminating the environment⁷¹. Although the utilization of single-use plastic would benefit to contain the spread and transmission of virus,

it has an inverse consequence on ecosystem and biodiversity⁷².

Production of bio-based plastics

The use of various types of plastic products in cosmetics and beauty salons necessitates emerging need for bio-based plastic products^{73(p)}. Bio-based plastics have the characteristic ability to reduce carbon footprint and manage waste efficiently thereby decreasing environmental pressure⁷⁴. Overcoming the current limitations posed by the pandemic, transition from petroleum-based plastic to bio-based plastics is a good alternative to reduce plastic pollution and act as environment-friendly alternative⁷⁵.

Synergistic role of government and public

A strong regulatory body approved by government should create awareness on utilization

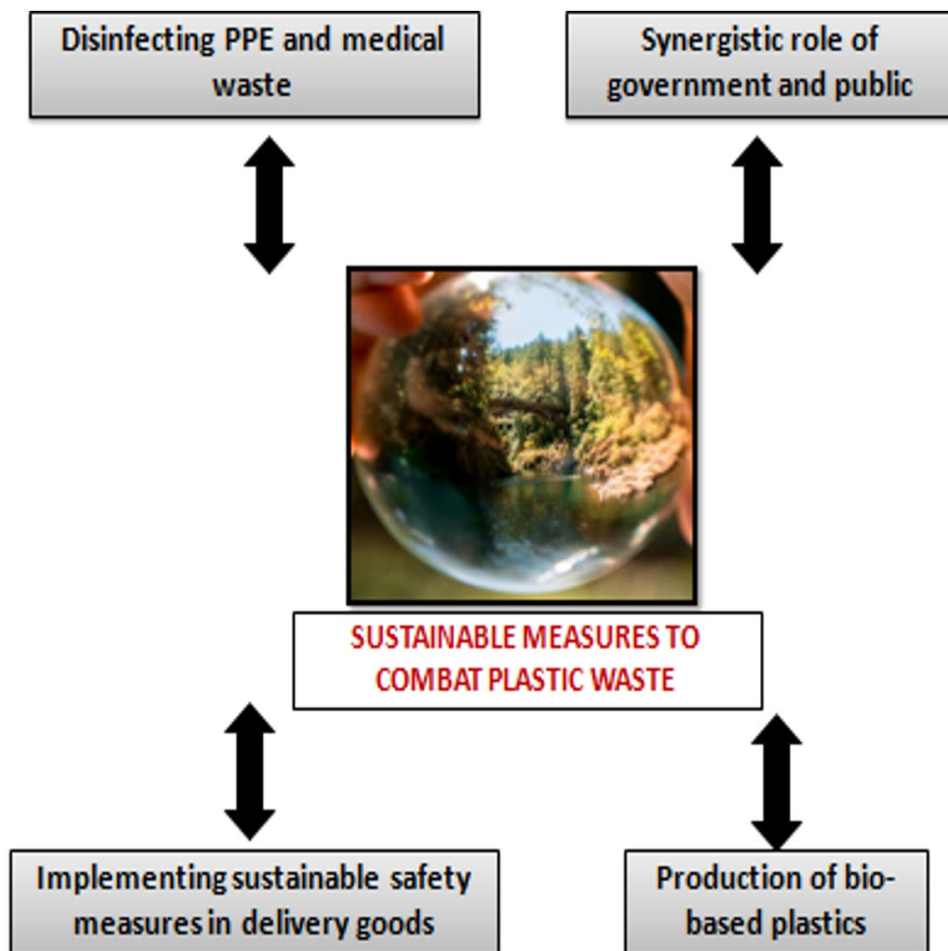


Fig. 4. Sustainable measures to overcome COVID-19 plastic waste problem

and disposal of plastics waste. Waste that cannot be recycled must be utilized as feedstock or biomass source to create energy⁶⁷. PPE kits and other plastic waste must be sealed in impermeable bags before disposal to have less harmful impact on the environment. Scientific knowledge and evidence is necessary to overcome the ongoing plastic pollution and advance technologies for future.

CONCLUSION

With the emerging COVID-19 pandemic, the topmost priority by all the people relies on their health and safety. However, the implications and its impacts in long run are undervalued by government and people worldwide. The physical impact of COVID-19 due to plastic generated has harmful consequences on the ecosystem. The use of plastic products might reduce the transmission of virus but could have detrimental effects on the marine environment and agricultural ecosystem post the pandemic. Not only plastic causes pollution, it takes many years to degrade and breaks into smaller fragments of microplastics and nanoplastics. These plastic pieces after inhalation by organisms can cause negative effects on aquatic flora and fauna. For example, latex gloves, entanglement by face masks and surgical plastics products could cause severe injuries to turtles, fishes, whales and other marine organisms. Rethinking and redesigning of PPE kits and plastic products is necessitated to overcome the plastic waste pollution. Improvements in recycling procedures to ensure sustainable use and improve air and water quality are recommended.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

AUTHORS' CONTRIBUTION

Both the authors have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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DATA AVAILABILITY

All datasets generated or analyzed during this study are included in the manuscript.

ETHICS STATEMENT

Not applicable.

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