

Editorial

Masks and the scourge of microplastic pollution

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Received: 23 June 2023

Accepted: 22 September 2023

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Personal protective equipment (PPE) has been the cornerstone of prevention of virus transmission during outbreaks like COVID-19.¹ The recent pandemic necessitated the widespread use of masks among the public. While safe disposal of masks is satisfactorily achieved in hospital settings, the unsafe disposal of masks used in the households is a growing environmental concern. Also called as the ‘plastic impact of the pandemic’, the burden of face mask litter has grown into a significant pollution problem.

The English word “mask” has been in use since early 16th century and is derived from French *masque* and Medieval Latin *masca* which mean a covering to hide the face.² The earliest documented use of medical masks (mask used for infection control) is in the last decade of the 19th century. In 1897, bacteriologist Carl Flügge, showed experimentally that respiratory droplets carried culturable bacteria. This finding convinced Johann Mikulicz, the head of surgical department at University of Breslau, Poland, to start wearing a face mask to cover the nose and beard. Mikulicz described mask as “a piece of gauze tied by two strings to the cap and sweeping across the face so as to cover the nose and mouth and beard”. Masks gradually gained wide popularity and most of the surgeons were using it by 1935. However, it was during the Manchurian plague of 1910-11 and the influenza pandemic of 1918-19 that masks came to be used outside the operation theatre, by doctors and patients. The effectiveness of masks in control of transmission become increasingly evident in cities like San Francisco where reduction in mortality from pandemic influenza was partly attributed to public health policies that mandated wearing of masks by general public. Reusable masks made of materials like paper and cotton were popular

during the 1930s. Gradually, manufacture of disposable medical masks has attracted considerable interest, with newer raw materials being used for better user-friendliness and filtration efficiency.³ There has been substantial increase in the production of masks to meet the ever-increasing global demand, as masks is a simple and cost-effective method of preventing spread of the virus.⁴

Cochrane and World Health Organization (WHO) have suggested that one should not always demand for evidence from randomized controlled trials, while evaluating public health measures among populations, such as assessing the efficiency of masks in controlling transmission of the virus among general public.^{5,6} A Cochrane systematic review that included 67 RCTs and observational studies found that “overall masks were the best performing intervention across populations, settings and threats.”⁷ There is adequate evidence available suggesting that a near-universal adoption of face masks by general public, when complemented by other public health measures such as quarantine and testing, can reduce the community spread over sustained use.⁸

While the use of disposable plastic masks gained quick universal acceptance among general public, disposal of used masks in environmentally safe manner has posed a challenge for the communities. In India, the Biomedical Waste Management Rules were laid down in 2016 and govern the disposal of masks used in healthcare setting. The absence of a streamlined public policy on disposal of used masks in domestic and non-institutional settings has snowballed into a significant environmental challenge of microplastic pollution. Due to slow rates of degradation, plastics persist in soil and water bodies for several

decades and tend to accumulate in the tissues of living organisms. Several physiological effects have been postulated about bioaccumulation of microplastics in humans but lack strong evidence base. Long term effects of microplastics on human beings is a research area of growing interest.⁹

MATERIAL USED IN PRODUCTION OF MASKS

Worldwide, the surgical masks are produced from polymer nanofibers. Disposable masks conventionally, have three layers made of non-woven, water-resistant, and coloured fabric. The microfiber or nanofiber fabric used in these layers provides the main filtration barrier.¹⁰ Various materials such as polypropylene, polyurethane, polyacrylonitrile, polystyrene, polycarbonate, polyethylene, etc. are also used in the production of surgical masks. These materials are plastic polymers that are non-biodegradable. Owing to shortage of surgical masks, environmental concerns, and rapid spread of novel coronavirus, cloth masks which were once widely used before the 1960s, regained public acceptance. Cloth masks are usually made of more than two layers of common textile material such as cotton. Several biodegradable and eco-friendly materials such as jute, coir, corn, paper, etc are also used in the production of the masks.

The N95 respirator is the most commonly used particulate-filtering facepiece respirator (FFP). When exposed to oil-based aerosols, there is a fall in the filtration-efficiency of respirators. The alphabet “N” indicates that the N95 respirator is not resistant to such a reduction in its filtration efficiency when exposed to oil-based aerosols.¹¹ N95 respirators are also made of synthetic polymer fibres, using the melt-blown process similar to surgical three-ply masks.¹² However, respirators used in healthcare settings have an additional water-resistant outer layer, commonly blue-coloured.

OBSERVATIONS FROM OUR STUDY AREA

We surveyed the premises of a residential complex in Chennai city for dumping of used masks. We analysed the area for type and quantity of masks thrown indiscriminately. These masks are not disposed of in accordance with the Biomedical Waste (Management and Handling) Rules, 2006. Also, these masks were not disposed of by the municipal authorities, rather, they undergo incomplete disintegration on earth. During the time period from 01 January 2022 to 30 April 2022, we collected a total of 650 gm of discarded masks. This included 475 gm of N95 masks and 175 gm of surgical masks. The masks were found to be in varying stages of biological disintegration. All the masks were made of non-biodegradable polypropylene plastic. We collected these discarded used masks during the time period and handed them over to the local recycling agency for further disposal.

FACE MASKS AND MICROPLASTIC POLLUTION

Ongoing COVID-19 pandemic necessitates use of billions of disposable face masks on a daily basis in community settings. Improper disposal of used masks raises health and environmental concerns of large magnitude. Indirect effects of mask waste on human health are due to microplastic pollution. Jie et al quantified that each surgical and N95 mask releases more than billion nano plastics and microplastics (NPs and MPs) into environment. These NP and MP particles are ingested by diatoms and enter marine ecosystem when fishes ingest diatoms.¹³ Microplastics pollute marine ecosystems. Research shown that more than 267 different species of marine organisms, 43% of marine mammals, 86% sea turtles and 44% sea birds, were affected by plastic litter.¹⁴

Microplastics are defined as “synthetic solid particles or polymeric matrices, with regular or irregular shape and with size ranging from 1-5 mm, of either primary or secondary manufacturing origin, which are insoluble in water.”¹⁵ In recent years, exposure to microplastics have substantially increased due to increasing use of plastic products. However, there is uncertainty associated with the risk to human health.

HEALTH HAZARDS OF MICROPLASTICS

Microplastics enter human body by ingestion. Studies have shown that NPs and MPs are present in sugar, salt, alcohol and drinking water.¹⁶ Presence of microplastics in mussels and sea food is well established. Marine ecosystems at all trophic levels have shown presence of microplastics.^{13,18} It is also assumed that humans consume up to 80 gm per day of microplastics in fresh fruits and vegetables cultivated on polluted soil.¹⁷

Following ingestion, particles smaller than 2.5 µm size pass through the gastrointestinal epithelium facilitated by mucosa-associated lymphoid tissue (MALT) and Peyer’s patches. Toxic effects attributed to their characteristics of inflammation and bio-accumulation in tissues. Inflammation is due to the hydrophobicity and chemical composition of MPs, and dose-dependent accumulation of MPs in tissues have been shown.¹⁹ Excretory system removes up to 90% of ingested MPs, with every 10 gm of stool shown to contain twenty plastic particles.^{18,20}

MPs and NPs are carried by wind and also enter the body aerially by inhalation.²¹ In addition to causing genotoxic and cytotoxic effects on the pulmonary epithelium and macrophages, nanoplastics cross the tissue barrier of alveolar epithelium and enter the bloodstream.^{21,22} Also, microorganisms adhere to the plastic surface to escape the action of UV radiation, and gain access to the lung.²³ Plastic components like polyethene and polystyrene have demonstrated cytotoxic effects on human brain cells and epithelium.²⁴ Studies have shown that nano-plastics in polystyrene can cross the placental barrier and renal

cortical epithelium of humans.^{25,26} Inflammatory conditions of lung due to inhalation of microplastics has been well documented.^{19,23,27} Although plastic is an inert material, inflammatory responses are attributed to the particle size, chemical composition and hydrophobic nature of microplastics.¹⁹ An overview of the health effects of microplastics, summarized from published research is shown in Figure 1.

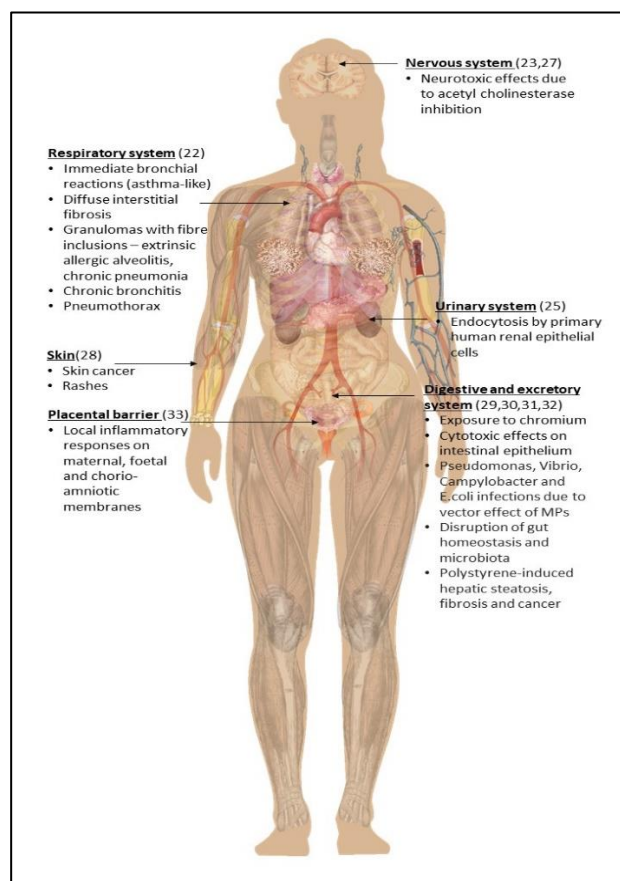


Figure 1: Effects of microplastics on human body.

(Image credit: Maj Anirudh K. Menon)

CONCLUSION

Biomedical Waste (Management and Handling) Rules were formulated in 2016 (amended in 2018 and 2019) to guide healthcare facilities in safe handling and disposal of biomedical waste. During the COVID-19 pandemic, large quantities of biomedical waste was generated in quarantined households and isolation centres. There is lack of clear demarcation between the waste management protocols for general waste and for such biomedical waste. India does not have dedicated waste-management system for biomedical waste from the households. The waste-collectors collect them without using an alcohol-based hand sanitizer. Used needles from insulin syringes have the potential to transmit bloodborne infections such as Hepatitis B virus and HIV. Policy makers should focus on the hazards to health and environment caused by improper disposal of biomedical waste from households,

and urban local bodies have to enforce guidelines by involving urban local bodies (ULBs), healthcare facilities and recycling agencies as stakeholders.



Figure 2: Conversion of plastic wastes to gasoline by a low-pressure pyrolysis plant in Chennai.

The Central Pollution Control Board (CPCB) has made suitable recommendations in this regard, in their fourth revision of guidelines for handling, treatment and disposal of waste generated during treatment/ diagnosis/ quarantine of COVID-19 patients.³⁵ The responsibility of segregating the waste generated at homes and quarantine centres into general solid (household) waste and biomedical waste lies with the residents and persons who operate quarantine centres. Household waste can be handed over to the municipal waste collectors identified by ULBs for final disposal. Used masks, gloves and tissues or swabs contaminated with blood or body fluids of COVID-19 patients, including used syringes, medicines, etc., constitute biomedical waste.³⁶ Masks and gloves used by persons other than COVID-positive patients should be kept in a paper bag for at least 72 hours, cut into two or more pieces (to prevent reuse), and can be disposed of as general waste. Management of such general waste, thereafter, falls under the scope of Solid Waste Management Rules, 2016 and Plastics Waste Management Rules, 2016 (Second Amendment, July 2022), notified by the Ministry of Environment, Forests and Climate Change. Although initially conceived as being pertinent to urban areas, the subsequent amendments to plastic waste rules have practically expanded the scope to rural areas too. The identified local governing bodies of the communities are responsible for ensuring that plastic waste is managed in such way that no damage is caused to the environment, the recyclable plastic waste fraction is channelized to recyclers, and ensuring that the processing and disposal of non-recyclable fraction of plastic waste is in accordance with

the guidelines issued by the central pollution control board.³⁷ Municipal bodies have to look at innovative approaches to handle plastic wastes. In Pallavaram Cantonment of Chennai city, plastic wastes are converted into gasoline by low-pressure pyrolysis (Figure 2).

Combustion of one tonne (1000 kgs) of plastic waste yields about 350 litres of gasoline in a day's operation. This gasoline can either be refined into different fractions of petroleum or used as such for combustion purposes in industries.

In the backdrop of re-emerging infectious diseases, and hitherto undocumented viruses and strains affecting humanity in the early 21st century, use of biodegradable and eco-friendly materials in production of masks and PPEs is an effort that will reap environmental benefits.

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Cite this article as: Menon AK, Mohan M. Masks and the scourge of microplastic pollution. *Int J Community Med Public Health* 2023;10:3958-62.