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Short Communication

Covid-19 face masks: A potential source of microplastic fibers in the environment

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HIGHLIGHTS

- Disposable face masks (single use) are used to slow down the transmission rate of Covid-19 from person to person.
- Unprecedented rise in the global production of face masks present a new environmental challenge due to Covid-19 pandemic.
- Polymer-based face masks waste management issues are increasing.
- Covid-19 is playing a key role in microplastic pollution.
- Research and community awareness will be successful in making the public mindful of this problem.

GRAPHICAL ABSTRACT

Since the emergence and detection of Covid-19 in China and its declaration as a pandemic by the World Health Organization (WHO) (Murray et al., 2020), various measures have been put in place in different countries across the world to contain the virus and its further spread. Governments at all levels have brought up different ideas, including lockdown (staying at home), which has been adjudged the most effective preventive measure so far. Others are social distancing, travel restriction, isolation, good hand hygiene (washing of hands), avoiding public or crowded spaces as well as the mass wearing of disposable face masks (Freedman, 2020; Lin et al., 2020; Chintalapudi et al., 2020). Although the disposable face masks were primarily made for the protection of health-care workers (HCWs) to prevent occupational hazards, non-medical professionals adopted the use of face masks during the outbreak of SARS in 2003 and *pdm H1N1* in 2009 (Elachola et al., 2020; Yang et al., 2008). Moreso, authorities had recommended the same for the masses to stem the widespread of these viruses. In regards to the current pandemic, researchers have advocated for the use of face masks by the general public until the mode of transmission of Covid-19 is fully understood (Leung et al., 2020). It has also been argued that it can help in reducing the number of times a person touches the face/mouth/nose with unwashed hands, which can significantly reduce the chance of infection. Previous studies have also demonstrated the effectiveness of face masks in protecting against respiratory infection during Hajj (Elachola et al., 2014; Barasheed et al., 2016).

The introduction of face masks (Wu et al., 2020) as one of the precautionary measures to slow down the transmission rate of Covid-19 from person to person has resulted in a global shortage of face masks for the most venerable group, which are the HCWs (Wu et al., 2020). According to the WHO estimates, approximately 89 million medical masks were needed to respond to Covid-19 each month (WHO, 2020). This demand has resulted in an unprecedented rise in the global production of face masks which are produced using polymeric materials. Major players in face mask production have therefore scaled up their output. For instance, China increased its daily production of medical masks to 14.8 million as of February 2020 (Xinhua, 2020). Also, according to the Japanese Ministry of economy, trade, and industry (METI), over 600 million order of face masks per month was secured as of April 2020 (METI, 2020). The demand is expected to increase as the number of Covid-19 infected persons globally stands at 3.84 million, with over 260, 000 deaths as of May 7, 2020 (Worldometer, 2020). Moreso, many countries are relaxing lockdown orders due to the adverse effects on the economy and mental health, and this could lead to a second wave of infection.

Disposable face masks (single use face masks) are produced from polymers such as polypropylene, polyurethane, polyacrylonitrile, polystyrene, polycarbonate, polyethylene, or polyester (Potluri and

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Needham, 2005). They consist of three layers; an inner layer (soft fibers), middle layer (melt-blown filter), and an outer layer (nonwoven fibers, which are water-resistant and usually colored). The melt-blown filter is the main filtering layer of the mask produced by the conventional fabrication of micro- and nanofibers, where melted polymer is extruded through tiny nozzles, with high speed blowing gas (Dutton, 2008). Fig. 1 shows the basic principle of face mask production through electrospinning (Zafar et al., 2016). There may exist variations in the formation of the product from one manufacturer to the other. Table 1 showed different face mask' brands and their description.

The increase in production and consumption of face mask across the world has given rise to a new environmental challenge, adding to the vast plastic and plastic particle waste in the environment. Some of these materials are getting into waterways from where they reach the freshwater and marine environment adding to the presence of plastics in the aquatic medium. For instance, OceansAsia, an organization committed to advocacy and research on marine pollution, reported in February 2020, the presence of face masks of different types and colours in an ocean in Hong Kong. Also, the collection of face masks along a highway and drainage in Ile-Ife, Nigeria, on May 5, 2020 (Fig. 2). This new emergence of face masks as environmental litter both in the terrestrial and aquatic environment is a piece of evidence that the global pandemic has not in any way reduced the challenge of increasing plastic pollution in the environment.

Single-use polymeric materials have been identified as a significant source of plastics and plastic particle pollution in the environment (Schnurr et al., 2018). For instance, plastic packaging materials, drinking bottles, and fast food containers are leading sources of microplastics pollution globally (Fadare et al., 2020). Similarly, disposable face masks (single use) that get to the environment (disposal in landfill, dumpsites, freshwater, oceans or littering at public spaces) could be emerging new source of microplastic fibers, as they can degrade/fragment or break down into smaller size/pieces of particles under 5 mm known as microplastics under environmental conditions. The Fourier-Transform Infrared Spectroscopy (FT-IR) analysis (see Supporting Information for details) of the degrading face masks (Fig. 3) was carried out using PerkinElmer, UATR Two, USA, against a plastic specific spectral library (Perkin Elmer ATR of Polymers Library). The spectra showed a characteristic peaks of a polypropylene for the outer layer (Fig. 3a) and polyethylene high density for the inner layer (Fig. 3b). The spectra provide a piece of evidence that face masks could increase the accumulation of their related microparticles in the environment within a short time.

Table 1
Different manufacturers' brand and their description (Leonas et al., 2003).

Mask name	Description
Tie-on surgical face mask	3-ply, pleated rayon outer web with polypropylene inner web
Classical surgical mask, Blue	3-ply, pleated cellulose polypropylene, polyester
Sofloop extra protection mask	3-ply, pleated blended cellulosic fibers with polypropylene and polyester, ethylene methyl acrylate strip
Aseptex fluid resistant	Molded rayon and polypropylene blend with an acrylic binder
Surgine II cone mask	Molded polypropylene and polyester with cellulose fibers
Surgical grade cone style mask	Molded polypropylene

The environmental implication of plastics and plastic particles pollution have been enumerated and demonstrated by erudite scholars in various literature (Browne et al., 2008; Cole et al., 2014; Galloway et al., 2017; Rist et al., 2018; Wright et al., 2013). Some of these adverse consequences include threat to aquatic lives, which constitute a major part of the food web and support to human existence. Plastic particles are getting into foods meant for human consumption, raising a concern on global food safety (Fadare et al., 2020). Reduction in aesthetic and recreational worth, which are vital to human social and mental stability. The presence of plastics in the environment has also been reported as contributing significantly to climate change due to carbon emission and a greater risk to the global food chain (Reid et al., 2019; Shen et al., 2019).

Another implication of this indiscriminately disposed face masks in the environment is the possibility of acting as a medium for disease outbreak, as plastic particles are known to propagate microbes such as invasive pathogens (Reid et al., 2019).

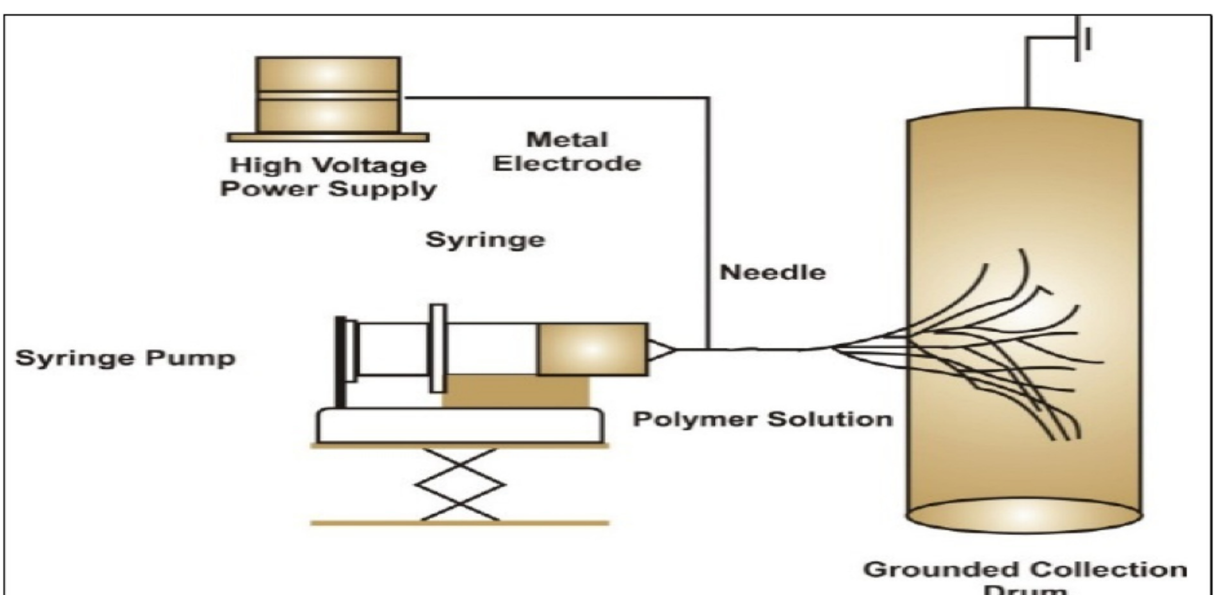

Fig. 1. Process of producing nanofibers through electrospinning used in face mask production (Zafar et al., 2016).

Fig. 2. Collection of various Covid-19 face masks of different types and colours from an ocean and terrestrial environment in Hong Kong and Nigeria respectively. Photo credit: OceansAsia (with permission) and Dr. Oluwatoyin Fadare.

Although there is currently no unified international regulation on plastics regulation and pollution management, probably due to conflict of economic interests, few countries have however, put in place strict measures to curb the unabated proliferation of plastic waste. For instance, the Marine Waste Project of the National Oceanic and Atmospheric Administration (NOAA), approved under the Marine Waste Action Acts by the European Commission, is expected to promote among other things, awareness towards plastic particles pollution through the public education program (Li et al., 2019). Also, countries like Ireland has placed levy on consumers of single-use bag, China and South Africa combined both ban and levies on retailers. While placing ban on face masks remains the least option at the moment, considering its positive impacts in the ongoing global fight against the Covid-19, sensitization of the populace can greatly help in the management of these litters. Furthermore, strengthening critical thinking in research to provide eco-friendly alternatives while enhancing effective waste management system can assist in finding a sustainable solution to plastic pollution. Mobilization and awareness on Covid-19 prevention are intense across the globe; it will indeed be laudable if the awareness on safeguarding our environment through reduction, elimination (where possible) and proper management of our disposable face masks can as well be carried along. Who knows? Plastic pollution may be the next world pandemic.

CRediT authorship contribution statement

Oluniyi O. Fadare: Conceptualization, Methodology, Investigation, Writing - original draft, Resources. **Elvis D. Okoffo:** Methodology, Writing - review & editing, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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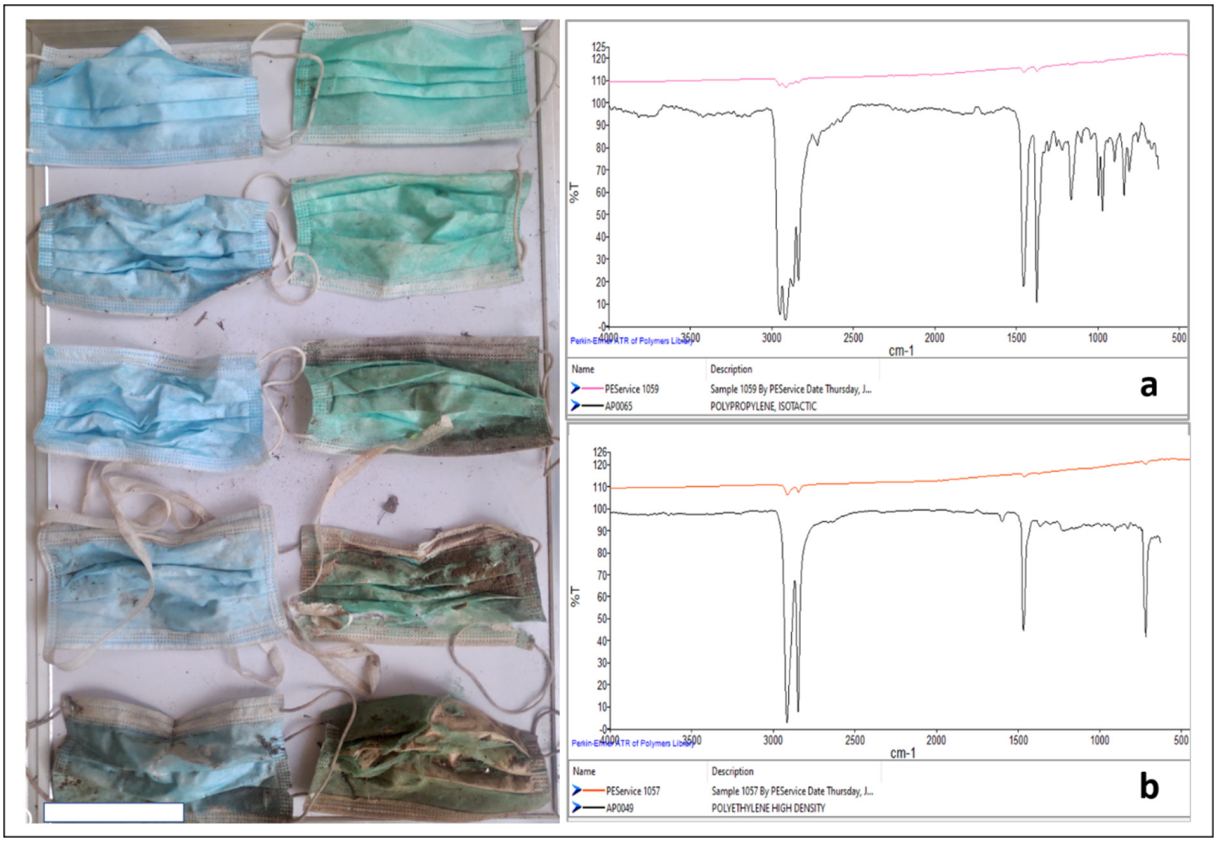

Fig. 3. Face masks at different stages of degradation in the environment and typical FT-IR spectra of the degrading fibers, outer layer (a) and inner layer (b). Photo Credit: Dr. Oluwatoyin Fadare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scitotenv.2020.140279.

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