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EDITORIAL

Electronic waste pollution and the COVID-19 pandemic

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How waste will be managed in the future? Will humans be able to design zero-waste products and systems, or will there be a continuous urban mining to recycle waste in the circular economy? Here, new insights have been recently provided by the COVID-19 pandemic, which has somehow accelerated society evolution and thus provided a glimpse at what might happen in the future. In particular, lockdowns have suddenly amplified working from home with computers, increased the amount plastic and paper packages and decreased waste transportations. Here, we discuss issues of electronic waste (E-waste) pollution, toxicity and urban mining.

Emergence of COVID-19

After the Spanish flu in 1918–1920, the year 2020 will remain a milestone in the history of pandemics with the outbreak of the coronavirus disease 2019 (COVID-19, Goldstein 2020). This virus first appeared in December 2019 in Wuhan, China, and then waved all over the world within 2–3 months. On May 2, 2021, more than 150 million cases and 3 million deaths have been documented globally (WHO 2021). The coronavirus spreads through respiratory droplets, such as cough and sneeze, and through direct physical contact, e.g. by touching the affected person and then touching eyes, nose and mouth (WHO 2020). The virus also spreads the contamination through air and faecal–oral contact (Qu et al. 2020; Sun and Han 2020). In some countries, the presence of the coronavirus in the air has been directly correlated with the presence of a high concentration of particulate matter, thus resulting in an increased rate of mortality (He and Han 2020; Han et al. 2020). The symptoms include fever, cough and breathing problems, and patients may suffer from respiratory distress syndrome and dyspnoea in critical situations (Huang et al. 2020; Zhu et al. 2020). People with less immunity are more prone to COVID-19 diseases. The USA is one of the most affected countries, followed by Europe and South-East Asia. The global systems of waste treatment have been strongly impacted by the pandemic, as discussed in the following.

Formal versus informal E-waste treatment

E-waste generation has globally reached 53.6 million metric tons (Mt) in 2019 and is predicted to amplify approximately to 74 Mt by 2030 (Forti et al. 2020). Developed countries such as the USA, Europe and Australia are the major producers of E-waste. These E-wastes are then transported to developing countries such as India, China, Ghana, Pakistan, Nepal, Bhutan and Vietnam due to easy availability of open space for dumping and low-cost labour for recycling purposes (Arya and Kumar 2020a; Chi et al. 2011; Balde et al. 2017). In developing countries, most E-waste is handled improperly through unscientific methods, commonly termed 'backyard recycling' or 'informal recycling', whereas E-waste from major companies and government sectors is collected and processed professionally by formal recyclers (Arya and Kumar 2020b). E-waste handled by the formal recycling sector adheres to norms and legislations, whereas the informal sector is unaware of scientific methods and ignores norms and legislations. For instance, in Germany, only 17.4% of the total E-waste is recycled by the formal sector, the rest remaining undocumented and thus either stored, traded, dumped or recycled under lower standards (Forti et al. 2020). E-waste workers benefit from the informal sector for their livelihood, but they are exposed to severe health hazards (Dutta et al. 2016; Rautela et al. 2021).

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As a consequence, new regulations and recycling facilities have been proposed for proper management because a large quantity of E-waste is handled improperly by an uneducated population in the informal sector (Arya et al. 2021). The COVID-19 period has induced an almost complete shutdown of facilities and transportation (Kumar et al. 2020). Therefore, the E-waste chain, including collection and transportation, has been severely affected. For instance, the quantity and collection frequency of E-waste were affected, workers availability and safety decreased, and there was an increase in retrenchment (Sharma et al. 2020; Lord 2020; ILO 2020). The similarities between E-waste and the virus are explained in the following.

E-waste as pollutant and vehicle for the virus

E-waste is an heterogeneous mixture of metals, plastics, resins and glass. E-waste contains non-hazardous metals, e.g. iron and steel, hazardous metals such as lead, cadmium, chromium, mercury, arsenic, nickel, copper, cobalt and lithium, precious metals such as gold, silver, platinum and palladium, and rare earth metals such as neodymium, praseodymium, tantalum and indium (Wath et al. 2010; Dasgupta et al. 2014). E-waste also contains organic and inorganic chemicals which pollute the environment upon waste dumping. Since the viability of the coronavirus on metals and plastics is nearly five days (Khan et al. 2021), E-waste is very likely to have contributed to the contamination of a large population. This hypothesis is supported by the fact that the routes of both the virus and E-waste are similar, for example touching or breathing near a contaminated computer (Fig. 1). Moreover, the common health hazards caused by the coronavirus and E-waste are respiratory problems, damage to the nervous system, skin diseases, orthopaedic complications and cancer (Ramachandra and Saira 2004; Chen et al. 2011; Begum 2013; Cong et al. 2018; Decharat 2018; Seith et al. 2019; Davis and Garb 2019; Huo et al. 2019; Gu et al. 2019; Xu et al. 2020; Amoabeng Nti et al. 2020; Nithya et al. 2020).

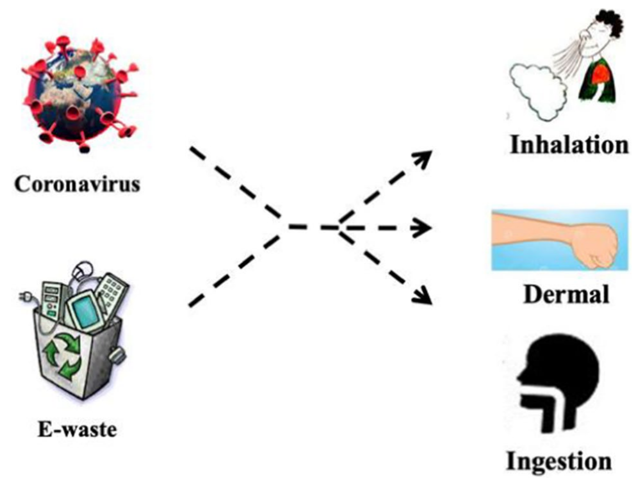

Fig. 1 The COVID-19 pandemic has induced an increase of electronic waste (E-waste). Both the virus and E-waste display similar transport routes and adverse effects such as respiratory problems and neurological damages. COVID-19: coronavirus disease 2019

Urban mining

The process of metal recovery from E-waste is known as 'urban mining' (Arya et al. 2021). Urban mining and recycling have potential to improve the country's economy and to decrease pollution and global warming. The main recycling methods start by a physical pretreatment, followed by pyrometallurgy, hydrometallurgy, electrometallurgy and biohydrometallurgy. E-waste contains more than 100 metals and materials which can be recycled and recovered (Cayumil et al. 2014; Kaya 2016; Garlapati 2016; Priya and Hait 2017; Dutta et al. 2018; Barnwal and Dhawan 2020; Nshizirungu et al. 2020; Nithya et al. 2020).

Circular concepts

New concepts are required to cope up with the pandemic and to manage E-waste. Collection is a major issue in developing countries, calling for the set-up of more waste collection centres accessible to the public. To avoid viral transmission, the formal recycling sector has already taken precautions in handling E-waste such as storing waste a few days before handling. The formal recycling sector has also applied common precautions including sanitization, physical distancing and wearing masks, gloves and personal protective equipment. More generally, all sectors should plan the fate of all E-waste components after product use, and this should be enforced by laws and governments. Various mobile applications have been invented for easy collection of E-waste from home, yet such applications should be better publicized. All registered formal recyclers should increase their individual recycling capacities to combat the flood of E-waste generated during COVID-19 pandemic. More generally, in the future circular economy, both industrial producers and consumers should be responsible for the life of manufactured products.

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