Wet wipes contribution to microfiber contamination under COVID-19 era: An important but overlooked problem

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Environmental Challenges

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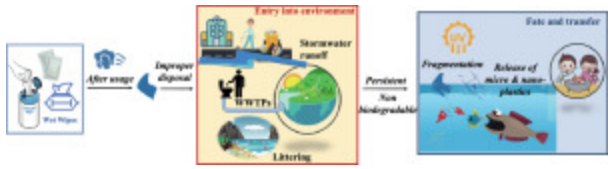
Highlights

- The usage of single-use disposable wet wipes increased during the COVID-19 outbreak.
- Wet wipes, in addition to personal protective equipment, have been identified as a key debris.
- Wet wipes are potential sources of microfibers contamination.
- Wet wipes contribution to global COVID-19 microplastic pollution is overlooked.

Abstract

Wet wipes for disinfection, sanitizing, and medical purposes, like personal protective equipment, have witnessed an upsurge in production and use as a result of COVID-19 outbreak. They are a potential source of microfibers and have recently been found in COVID-19 plastic litter survey campaigns conducted in a few marine environments around the world. This mini-review highlights wet wipes as a one of the key debris items contributing to the growing COVID-19-related microplastic pollution, and there are significant gaps in our understanding of microfiber release under different environmental conditions, morphological, and chemical degradation signatures, necessitating a comprehensive study of disinfectant wipes. Thus, we urge microplastic researchers to investigate the environmental implications of wet wipes in order to keep the total estimate of the plastic problem up to date and manage the associated environmental challenges.

Graphical abstract



Keywords

COVID-19

Plastic pollution

Polyester

Microfiber

Marine

The Coronavirus disease (COVID-19) is still present throughout the world, as are concerns about the plastic waste problem caused by the pandemic's personal protective equipment (PPE) like face and surgical masks, gloves, and laboratory materials (Vanapalli et al., 2021; De-la-Torre and Aragaw, 2021). As a result of the COVID-19 pandemic, there is mounting evidence of an unusual surge in PPE waste, particularly disposal face masks (Dharmaraj et al., 2021; Sangkham, 2020). According to a recent study, Asian countries generated substantially more plastic waste (1.51 million tons) than European countries (0.48 million tons) (Chowdhury et al., 2021). Almost everyone reading this has stumbled across some type of discarded PPE in surrounding environment in their daily lives. COVID-19 waste, specifically different types and colors of abandoned masks and PPE has been found on urban beaches and coastline all over the world (Thiel et al., 2021; De-la-Torre et al., 2021; Ardusso et al., 2021; Okuku et al., 2021). Disposable masks have been identified in the literature as a source of thousands to millions of micro and nano fibers entering the marine environment (Saliu et al., 2021; Fadare and Okoffo, 2020; Aragaw, 2020; Shruti et al., 2020). More alarmingly, they have also shown to entangle and be ingested by organisms (Neto et al., 2021). On the one hand, there is a growing body of research concerning the fate of PPE, especially masks in terms of microfiber release and degrading features under diverse environmental conditions (Saliu et al., 2021; Wang et al., 2021; Shen et al., 2021). Other anthropogenic sources of microplastics contamination, such as wet wipes, have been neglected in microplastics studies despite their massive increase alongside PPE during the COVID-19. Furthermore, in recent published articles and editorials, wet wipes are either not mentioned at all or only discussed barely (Rasmussen, 2020; Chowdhury et al., 2021; Walker, 2021). This mini-review attempts to examine current knowledge on wet wipes in order to identify them as a potential microplastics pollution contaminant during the COVID-19 pandemic and to indicate future research needs.

Wet wipes, like PPE, are nonwoven fabrics comprised of synthetic fibers (staples or continuous) such as polyester, polypropylene, rayon, and nylon (Pajda, 2019). For example, Seventh Generation employs polyester spun lace in their wipes, as well as PPE including masks, medical gowns, and medical wipes. Since the onset of COVID-19, demand for a variety of wet wipes such as baby wipes, facial wipes, moist flushable wipes, and household wipes has exploded, owing to global awareness of sanitation and personal hygiene, as well as increased cross-contamination issues under the influence of social media and other promotional media. Consequently, a higher proportion of people who have never used disinfectant wipes before began using them for the first time. Apart from that, disinfectant and medical wipes have primarily been utilized in the medical profession, hotels and restaurants, schools, and universities to disinfect surfaces on a massive scale as a preventative measure in the fight against the COVID-19 pandemic presently underway. Additionally, sanitizing wipes have been distributed to travelers flying to effectively combat COVID-19 spread (Fig. 1a). To meet global demand, many wipes manufacturers have increased manufacturing. For instance, according to a recent report, Clorox has increased its output from 1 million packages of wipes per day in 2020 to 1.5 million packages daily in first quarter of 2021 (Stankiewicz, 2021). With a compound annual growth rate (CAGR) of 5.3 percent, the worldwide wipes market is predicted to increase from $39.6 billion in 2020 to $41.69 billion in 2021.

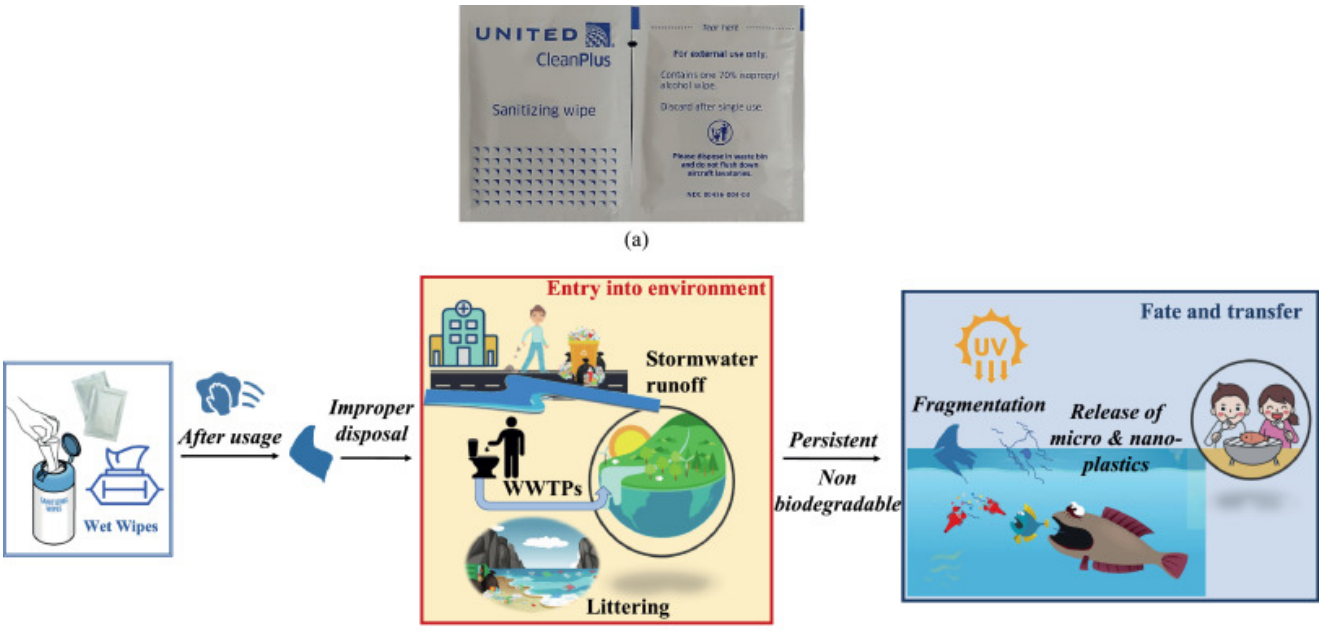


Fig. 1. (a) Picture illustrating sanitizing wipe distributed to flight passengers during COVID-19. (b) The environmental fate of wipes-derived microplastics, particularly microfibers, is graphically displayed.

Because wet wipes are single use, like most PPE, significant levels of disposal are expected, and flushing of used wet wipes after usage may increase. As a result, governments in several countries have taken significant waste control measures. For example, during COVID-19, the city of Toronto's waste management division issued Special Waste Disposal Instructions to notify citizens about how to dispose of personal hygiene and sanitary waste (e.g., "wipes, tissues, napkins, paper towels, and other sanitary and hygiene goods") (City of Toronto, 2020). However, due to poor waste management, the lack of a waste disposal strategy, and any purposeful or unintentional disposal into the environment, wet wipes would wind up in nature and readily reach the marine environment (Fig. 1b). Even before the COVID-19 outbreak, in March 2019, about 23,000 wet wipes were retrieved from one stretch of the Thames beach and 473 garbage bags of wet wipes were collected from the coastline in Barnes, West London (Thames21, 2019). Worse yet, evidence of discarded wipes ending up in the environment has been found during recent COVID-19 plastic litter survey activities in many parts of the world (Table 1). Wipes comprised between 8% and 46% of the total COVID-19-related litter collected in Canada and Peru (Ammendolia et al., 2021; De-la-Torre et al., 2021). According to another survey, wipes are the most common item spotted on the streets of Mkomani and Nyali beaches, following masks (Okuku et al., 2021). The presence of wipes among COVID-19-related litter items indicates a rapid increase in abundance along coastlines and in the wider marine ecosystem, implying that it has become one of the major sources of marine litter pollution besides PPE. It also points out that wipes found along or near coastal streets may have more direct paths into the aquatic ecosystem, necessitating rigorous monitoring of these items.

Table 1. Recent reports and evidence of wipes in environments around the world.

Study location	Environment	Key findings	Reference
Canada	City/urban	Photographic evidence of masks, gloves, wet wipes, and medical containers	Prata et al., 2020
South Africa	Urban	Spotted wet wipes during the sampling campaign April – June 2020	Ryan et al., 2020
Peru	Beach	A total of 26 wet wipes were counted during the sampling campaigns in urban beaches, Lima.	De-la-Torre et al., 2021
Chile	Beach	Photographic evidence of wet wipes in Amarilla beach, Antofagasta, and Papudo beach in Santiago de Chile.	Ardusso et al., 2021
Canada	City	Disinfecting wipes constituted 25% of total plastic debris collected from the metropolitan city of Toronto, Canada.	Ammendolia et al., 2021

Study location	Environment	Key findings	Reference
Kenya	Beach	Wet wipes and personal protective equipment were the most common plastic litter items found on the beaches of Mkomani and Nyali.	Okuku et al., 2021

Wet-wipes have been an issue for wastewater treatment plant operators for many decades. The overall fate and transfer of wipes in the marine environment is depicted in Fig. 1b. Wet wipes are non-biodegradable and can stay for up to 100 years in the environment, where they can fragment and produce smaller size plastics, namely micro- and nanoplastics (MCS, 2017; Munoz et al., 2018). Wet wipes have been recently identified as a potential source of synthetic white microplastic fibers in the environment, both after disposal and when used as cleaning agents (Briain et al., 2020; Lee et al., 2021). These white microplastic fibers from wet wipes can form nanoplastics after being exposed to the environment and weathering (Briain et al., 2020; Lee et al., 2021). Organisms may ingest them, transferring potentially harmful contaminants (Mishra et al., 2019; Kutralam-Muniasamy et al., 2020; Lima et al., 2021). It is particularly concerning now that they are making their way into the marine food system, potentially posing a human health risk (Mishra et al., 2019; Lima et al., 2021). Only one study has been published so far that looked at the release ability of microplastics produced from wet wipes in a simulated experiment (Lee et al., 2021). The researchers revealed that varied conditions (such as rubbing by hand and immersing in distilled water) result in different amounts of polyester microplastics (106 - 1066 per sheet) being released, with the majority of fibers (>90%) being 100 μm in size. But it lacks experiments mimicking environmental conditions, and the wet wipe samples were not weathered, leaving important gaps in our understanding of the effects of wet wipes on microplastic contamination. At the same time, from the findings of Lee et al. (2021), we suggest that humans are exposed unknowingly to the microfibers via dermal contact while cleaning with wipes, and if 1% of all wet wipes are improperly disposed of, millions of microplastics will be released into the environment. Taking together, it is confirmed that if any used wet wipes are disposed of improperly and not collected, they may become a significant source of micro- and nanoplastics in the aquatic environment. We believe that wet wipes prepared with smaller fibers for effective capturing of very small particulate like COVID-19 from surfaces would contribute more to the mounting problem of microplastic pollution. We also know that the pandemic's large surge in used single-use PPE and wet wipes is increasing the amount of waste transferred to landfills or burned in incinerators. However, several studies have shown that landfill leachates and incinerated remnants can still release large amounts of microplastics into the environment (Silva et al., 2021; Sun et al., 2021). Furthermore, microplastics from wet wipes discharged in wastewater treatment plants are not permitted into the aquatic environment, although sewage sludge can find its way into the ecosystem (Briain et al., 2020). Therefore, it is reasonable to assume that improper disposal, burial, or incineration of used wet wipes will continue to be a source of microplastics contamination in

marine environment. Given that they are individually wrapped in plastic or come in a pack of multiples in a plastic box/wrap, it is not surprising that the plastic wrap/box may combine with PPE waste, if discarded improperly, to generate a significant source of microplastic contamination. The survey of Ammendolia et al. (2021) reported discarded plastic containers of disinfectants in the streets of a metropolitan city in Canada. Overall, it can be said that the environmental threat from wet wipe and its associated plastic wastes is expected to grow with continuous production and usage under tremendous pressure posed by COVID-19 in the world.

To summarize, wet wipes are identified as one of the important debris items among the growing plastic wastes of COVID-19 and immediate attention should be given to the concerns associated with them. The world uses wet wipes or disinfectant wipes as an option to keep their items clean and disinfected, and these wipes are likely to contaminate the marine environment. Problems caused by wet wipes are inevitable when they are poorly disposed or handled in the environment. Meanwhile, scientists, politicians, and waste management experts are collaborating to make instructional materials more accessible and available to people, allowing them to properly use and dispose of PPE and other health and safety items, potentially minimizing COVID-19-related littering. Despite our little understanding of wet wipe microfiber release, there are several important gaps that need to be filled in order to offer a more solid evidence base on wet wipes for the understanding of global COVID-19 microplastic pollution. The following is a list of some of the future research needs:

(1)
There are currently no quantitative estimates of how much plastic pollution from wet wipes will enter the ocean. Municipal solid wastes should also be closely monitored in order to collect data on these products (e.g., PPE and wet wipes).

(2)
Future research should target on quantifying the number of microfibers released into the marine environment by wet wipes, as well as collecting more debris data from the pandemic.

(3)
To gain a thorough understanding of the wipes collected from the environment, their chemical composition should be determined.

(4)
The majority of the current estimates are based solely on PPE (Haque et al., 2021; Chowdhury et al., 2021), and we demand that the knowledge base on global plastic waste at the time of COVID-19 be amended and updated to include other anthropogenic sources.

(5)
There are no defined protocols in place for accurately monitoring COVID-19-related litter items for future investigations, and marine organizations can take the initiative to offer the essential guidelines for global harmonization of surveys.

(6)
We recommend revisiting the survey after a short period of time to identify the levels of plastic contamination in the pandemic's slowdown, which can be compared to the previous survey and to gain better understanding of public perceptions on the disposal of these items.

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.

Acknowledgments

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