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Editorial

Environmental Microplastics and the Lung

Plastic, practically perfect in every way. It is durable, versatile, and inexpensive, making it one of the most ubiquitous materials in the global economy. Today, it is difficult to imagine a world without plastic. However, there is a problem: plastic is not biodegradable. It accumulates in landfills and the environment where it breaks down into smaller, potentially microscopic pieces. When these fragments measure less than 5 mm in length, they are known as microplastics.

Since it became commonplace in the 1930s, humans have spread plastic everywhere: we can find it from the depths of the Mariana Trench to the top of Mount Everest. Little by little, we are discovering the cost of this ubiquity to both the planet and our own health. The problem became evident a few years ago when marine biologists began finding plastic in the stomachs of seabirds and some marine animals. Later, we discovered that humans ingest significant amounts of plastic in our diet; it is estimated that we consume up to 5 g of plastic per week, the equivalent of a credit card.[1] Microplastics have been detected in seafood, vegetables, salt, beer, and drinking water, as well as in human biospecimens such as feces, urine, blood, and even the placenta. Recently, they have also been detected in the lungs, so the time has come to focus on the respiratory system.

In 1998, Pauly et al. observed synthetic fibers in surgically resected lung tissue samples from patients with pulmonary neoplasia.[2] However, it was not until last year that the presence of microplastics in the human lung was confirmed. In August 2021, Amato-Lourenço et al. reported that microplastics were found in 13 of 20 human lung tissue autopsy samples.[3] Subsequently, in the spring of 2022, microplastics were detected in 13 surgically resected lung tissue specimens.[4] Finally, in June 2022, microplastics were detected in 30 of 44 bronchoalveolar lavage samples from patients with respiratory disorders,[5] confirming that microplastics can be inhaled into the deepest regions of the lung.

Plastic microfibers, such as those derived from synthetic clothing, factories, or plastic objects, are so miniscule that they can easily become airborne. In fact, these pollutants are present in the atmosphere in significant quantities. In the context of environmental pollution, microplastics are considered particulate matter (PM). However, they are more difficult to detect than other pollutants, suggesting that their concentrations may be underestimated. In cities, microplastics from tire wear-and-tear alone account for up to 8.5% of PM10 (PM $\leq$ 10 μm in diameter) and 10% of PM2.5.[6] But airborne microplastics have also been detected in remote locations such as Antarctica, indicating that atmospheric microplastic contamination is a global problem. Microplastic concentrations indoors, where we humans spend the majority of our time, tend to be higher than those outdoors. It is estimated that six out of every 20 kg of dust produced in our homes each year are microplastics.[7] Recent studies indicate that inhalation may be the primary route by which microplastics enter our bodies.[8] For example, during a dinner featuring contaminated wild mussels, our bodies would absorb more microplastics by inhaling airborne microfibers—such as those derived from our own clothes or carpets—than by eating the mussels.

Perhaps the time has come to stop looking for microplastics. Wherever we look, we already know that they will be there. The real question is, what consequences can microplastic inhalation have for our health? Are plastics inert, or can they activate inflammation-promoting immune responses or facilitate tumorigenesis? It is not difficult to find examples of other seemingly harmless substances that, years later, were found to exert undesirable effects on respiratory health. Indeed, laboratory research with *in vitro* and animal models indicates that microplastics can have detrimental effects on the respiratory system, such as inflammation, alterations in cell metabolism and adhesion,[9] and changes in the expression of proteins associated with apoptosis.[10] Although the exposure levels in these studies differ from those in the environment, occupational health studies have similarly revealed that polyester and nylon fiber processing can elicit symptoms such as cough, dyspnea, and wheezing, and may even facilitate the pathogenesis of diffuse interstitial lung disease.[11] In addition, environmental microplastics can contain toxic additives; adsorb other pollutants, such as heavy metals, or transport pathogens through the air.[12] Indeed, a growing body of literature indicates that the presence of environmental microplastics in human respiratory specimens is associated with higher rates of ground-glass malignant lung nodules,[13] pathogenic colonization, bronchial obstruction, and reduced lung function (Baeza et al., 2022).

Since 2016, we have known that microplastics are present in the air we breathe.[14] However, data concerning their possible consequences for human health are limited. We do not seem very concerned with this issue. Nevertheless, breathing plastic seems ominous. Plastic production is growing steadily year after year: from 2.3 million tons in 1950, to 448 million tons in 2015, to potentially at least twice that amount by 2050. In recent years, several proposals have emerged that aim to restrict the use of plastics, such as the European regulation 'Strategy for Plastics in the Circular Economy'. However, COVID-19 pandemic has not only postponed these measures but has also triggered the production of single-use plastics.[15] Without a doubt, our exposure to airborne microplastics will continue to increase in the coming years. An improved evalu-

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ation of our real exposure levels to these pollutants, together with a better understanding of their roles in respiratory pathology, is critical.

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