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Plastics, Fossil Carbon, and the Heart

Philip J. Landrigan, M.D.

Plastics have enabled extraordinary advances in virtually every area of medicine and have made our lives immeasurably more convenient. Multiple lines of evidence now indicate, however, that plastics are neither as safe nor as inexpensive as they seem. The benefits of plastics come at great and increasingly visible costs to human health and the environment.

Plastics are manufactured chemical materials.[1] Fossil fuels — gas, oil, and coal — are the main feedstocks of plastics, and fossil carbon corporations such as ExxonMobil are their principal producers. Plastics comprise a polymer matrix plus thousands of chemical additives that impart such properties as color, stability, flexibility, flame resistance, and water repellency. Many additives are toxic; these include carcinogens, neurotoxicants, and endocrine disruptors such as bisphenols and perfluorinated and polyfluorinated substances that can disrupt lipid metabolism and increase the risk of diabetes, cardiovascular disease, and stroke.[2]

Exponential increases in production are the main cause of the worsening harms of plastics (Fig. 1). Worldwide, the annual output has grown from less than 2 million tons in 1950 to approximately 400 million tons today.[3] This output is projected to double by 2040 and triple by 2060 as producers pivot to plastic in anticipation of decreasing demand for fossil-based energy.[4] Disposable, single-use items account for about 40% of current production and contribute disproportionately to the accumulation of plastic waste. Plastic waste is ubiquitous in the environment, where it breaks down into chemical-laden microplastic and nanoplastic particles.

As is often the case with new hazards, the health risks of plastics were first recognized in workers. Early warnings included a cluster of hepatic angiosarcomas in workers in Kentucky who had occupational exposure to polyvinyl chloride polymerization[5] and cases of interstitial lung disease in Rhode Island textile workers exposed to nylon flock.[6] Increased rates of premature birth, low birth weight, asthma, and pediatric cancers in so-called fenceline communities near fracking sites and production facilities show that the harm created by plastics and production of plastics extends beyond the workplace and falls disproportionately on low-income communities of color.[7] The 2023 rail disaster in East Palestine, Ohio, underscores the dangers of transportation of plastics chemicals. Data from the National Biomonitoring Surveys of the Centers for Disease Control and Prevention (https://www.cdc.gov/biomonitoring/index.html) suggest that plastic additive chemicals are present in the bodies of nearly all Americans. The Minderoo Monaco Commission has concluded that plastics endanger human health at every stage of the plastic life cycle.[1]

In this issue of the *Journal*, the results of the prospective study by Marfella et al. on the association of microplastics and nanoplastics with cardiovascular outcomes further expand our understanding of the health hazards posed by plastics.[8] This study, which included 312 patients who underwent carotid endarterectomy, showed that microplastics and nanoplastics were detectable in the excised plaque of 58% of the patients. The presence of microplastics or nanoplastics in carotid artery plaque was associated with a subsequent risk of nonfatal myocardial infarction, nonfatal stroke, or death from any cause that was 2.1 times that in patients whose plaques did not contain microplastics or nanoplastics. Patients with microplastics or nanoplastics in their plaque

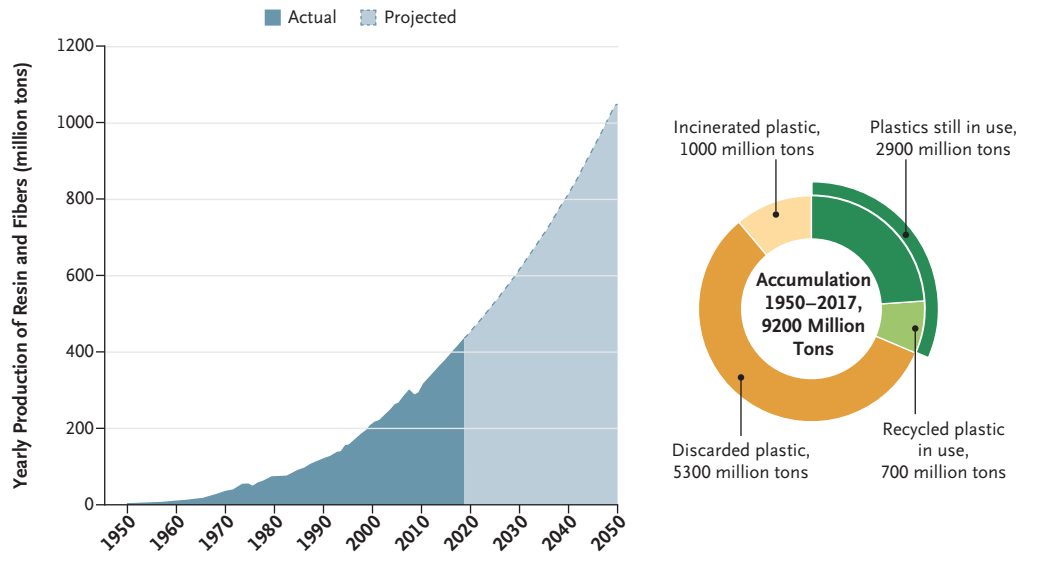

Figure 1. Global Plastic Production, Accumulation, and Trends.
Adapted with permission from GRID–Arendal.

tissue also had elevated expression of circulating inflammatory markers.

Humans are exposed to microplastics and nanoplastics by means of ingestion and inhalation. Previous investigations have detected microplastics and nanoplastics in multiple tissues, including colon, placenta, liver, spleen, and lymph node tissues.[1] Animal studies indicate that microplastics and nanoplastics can cause toxic effects at multiple sites, potentially by inducing oxidative stress.[1] Until now, information on the health effects in humans of ingested or inhaled microplastics and nanoplastics has been scant.

The report by Marfella et al. provides evidence that microplastics and nanoplastics are associated with cardiovascular disease outcomes in humans. Although we do not know what other exposures may have contributed to the adverse outcomes among patients in this study, the finding of microplastics and nanoplastics in plaque tissue is itself a breakthrough discovery that raises a series of urgent questions. Should exposure to microplastics and nanoplastics be considered a cardiovascular risk factor? What organs in addition to the heart may be at risk? How can we reduce exposure?

Although there is much we still do not know about the hazards to health and the environment posed by plastics, the information now available is cause for concern. Current patterns of production, use, and disposal are not sustainable.[9] In response to the growing problem of pollution from plastics and production of plastics, the United Nations has resolved to develop a Global Plastics Treaty, and negotiations are under way.[10]

What can physicians and other health professionals do? The first step is to recognize that the low cost and convenience of plastics are deceptive and that, in fact, they mask great harms, such as the potential contribution by plastics to outcomes associated with atherosclerotic plaque. We need to encourage our patients to reduce their use of plastics, especially unnecessary single-use items. We need to inventory our own and our institutions' use of plastics and identify areas for reduction. We need to express our strong support for the United Nations Global Plastics Treaty. We need to argue for inclusion in the treaty of a mandatory global cap on plastic production, with targets and timetables, restrictions on single-use plastics, and comprehensive regulation of plastic chemicals.[10]

The plastics crisis has grown insidiously while all eyes have focused on climate change. Like solutions to climate change, resolution of the problems associated with plastics will require a wide-scale transition away from fossil carbon. The path will not be easy, but inaction is no longer an option.

Disclosure forms provided by the author are available with the full text of this editorial at NEJM.org.

From the Program for Global Public Health and the Common Good, Boston College, Boston, and Centre Scientifique de Monaco, Monaco.

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