Common Seas

We eat and breathe plastic. How does it affect our health?

A deep dive into the unknown effects of plastics on our health

By **John Vidal and Jo Royle**

About Common Seas

Common Seas is a not-for-profit enterprise, based in the United Kingdom, that researches, designs and implements practical project-based solutions to our global plastic pollution crisis. Our mission is to quickly and significantly reduce the amount of plastic waste produced and stop it polluting rivers and seas.

We currently do this through four projects:

Plastic Drawdown

Helping governments understand and tackle plastic pollution

Clean Blue Alliance

Delivering practical on-the-ground solutions to cut plastic pollution

Ocean Plastics Academy

Inspiring the next generation of sea champions

Healthy Me, Healthy Sea

Researching and reporting how plastic affects our health

About Healthy Me, Healthy Sea

Common Seas is directing world-first research to understand if plastic particles are present in our blood and body tissue. We bring together a broad team of academic, medical, legal and advocacy experts to investigate the alarming links between plastics and a wide range of human health risks, from air pollution, to plastic acting as a disease-vector, to microplastic contamination.

It is widely understood that microplastic particles get into our bodies via the air we breathe, water we drink, clothes we wear and food we eat, but we don't know how serious this may be for our health.

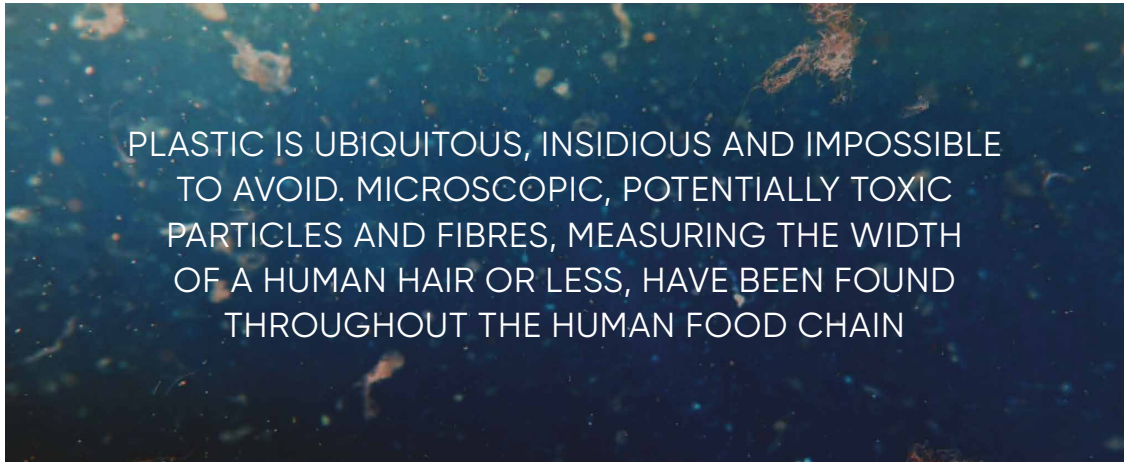
Because current research is so behind the curve, we must act fast to investigate, understand and prioritise issues – with the goal to drive urgent, large-scale action.

Overview

Plastic pollution has invaded life from the arctic to the equator. Vast amounts litter oceans, cities and beaches. Micro-sized plastic particles and minute fibres are accumulating in soils and sediments. Plastic is now in the air we breathe, the water we drink, the clothes we wear and the food we eat.

Plastic is ubiquitous, insidious and impossible to avoid. Microscopic, potentially toxic particles and fibres, measuring the width of a human hair or less, have been found throughout the human food chain, in sea food[1,2], insects[3], shellfish[4], bottled, tap and well water[5] and salt[6]. Even enjoying a pint of beer[7], a soft drink[8], or a sweet treat containing honey and sugar[9] might no longer be so carefree – or plastic-free - as you think.

The world's oceans teem with far more debris than previously thought[10]. Nearly all the pollution that ends up as minute pieces in water starts on land, first into rivers and onto beaches via degrading bags, bottles, and other plastic items, washing machines, sewers, overflows, waste dumps, incinerators, and industrial processes. These pathways require further mapping.



There is now mounting concern that these under-studied plastic particles threaten health by presenting a potential source of toxic chemicals[11] or dangerous bacteria to the human body, or by causing physical impacts like unbalancing our immune system[12,13,14]. How much people ingest, drink and breathe, and what effect this is having on short and long-term health, and what are safe concentrations are still poorly understood.

Last year, researchers found particles of nine out of 10 different types of plastic in the stool of people from Finland, Italy, Japan, the Netherlands, Poland, Russia and the UK. Although substantial further research is required to validate this, the Austrian researchers estimated that over half the world's population might have microplastics in their stool[15].

[1] Rochman, C. M., et al. (2015). Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Scientific reports, 5, 14340.
[2] Lusher, A. L., et al. (2013). Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel. Marine pollution bulletin, 67(1-2), 94-99.
[3] Windsor, F. M., et al. (2019). Microplastic ingestion by riverine macroinvertebrates. Science of the Total Environment, 646, 68-74.
[4] Van Cauwenberghe, L., & Janssen, C. R. (2014). Microplastics in bivalves cultured for human consumption. Environmental pollution, 193, 65-70.
[5] Mahon, A. M., et al.. (2014). Scope, fate, risks and impacts of microplastic pollution in Irish freshwater systems. Epa Research Programme, 2020.
[6] Yang, D., et al. (2015). Microplastic pollution in table salts from China. Environmental science & technology, 49(22), 13622-13627.
[7] Liebezeit, G., & Liebezeit, E. (2014). Synthetic particles as contaminants in German beers. Food Additives & Contaminants: Part A, 31(9), 1574-1578.
[8] Il Salvagente (2018), In Italy the first analysis carried out by Il Salvagente find microplastics in industrial soft drink, accessible at: https://bit.ly/2qh1J7y
[9] Liebezeit, G., & Liebezeit, E. (2013). Non-pollen particulates in honey and sugar. Food Additives & Contaminants: Part A, 30(12), 2136-2140.
[10] Lebreton, L., et al. (2018). Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic. Scientific reports, 8(1), 4666.

[11] The Guardian (2016), People may be breathing in microplastics, health expert warns, accessible at: https://bit.ly/2baorY0
[12] Revel, M., et al. (2018). Micro (nano) plastics: A threat to human health?. Current Opinion in Environmental Science & Health, 1, 17-23.
[13] Vethaak, A. D., & Leslie, H. A. (2016). Plastic debris is a human health issue.
[14] Wright, S. L., & Kelly, F. J. (2017). Plastic and human health: a micro issue?. Environmental science & technology, 51(12), 6634-6647.

THERE IS NOW MOUNTING CONCERN THAT THESE UNDER-STUDIED PARTICLES THREATEN HEALTH BY PRESENTING A POTENTIAL SOURCE OF TOXIC CHEMICALS OR DANGEROUS BACTERIA TO THE HUMAN BODY, OR BY CAUSING PHYSICAL IMPACTS LIKE UNBALANCING OUR IMMUNE SYSTEM

While most attention has been paid to plastic in the ocean, the reality is that everyone, from pregnant mothers and the unborn child, to old age pensioners and workers in rich and poor countries, may be being exposed– and the question remains, does this increase our chances of becoming ill[16]?

Information about how plastics may be affecting human health is still limited but scientists are now calling for a complete rethink about how plastics are made and disposed of. Bigger, better, and more definitive studies are needed to investigate the toxic characteristics of microplastics, their behaviour in the human body and what constitutes a safe threshold for exposure when inhaled or eaten.

[15] EurekAlert! (2018), Microplastics discovered in human stools across the globe in 'first study of its kind', accessible at: https://bit.ly/2nPxFIP
[16] Barboza, L. G. A., et al. (2018). Marine microplastic debris: An emerging issue for food security, food safety and human health. Marine pollution bulletin, 133, 336-348.

The Facts

Plastic never goes away. The vast majority is nearly indestructible and lasts for hundreds, if not thousands of years. Under the action of waves, wind, oxygen, heat, ultraviolet light and friction, it simply fragments and breaks down into smaller and smaller particles.

As the global economy expands, its use escalates and human exposure to microplastics grows. Since the 1950s when plastics were first mass-produced, an estimated 8.3 billion tonnes have been manufactured of which nearly 80% is believed to have been landfilled or to be still in the natural environment[17]. Production increases about 3% a year and is forecast to double again in the next 30 years, by which time another 30 billion more tonnes may be manufactured annually[18].

[17] Geyer, R., et al. (2017). Production, use, and fate of all plastics ever made. Science advances, 3(7), e1700782.
[18] Centre for International Environmental Law (CIEL) (2017), Fueling Plastics: New Research Details Fossil Fuel Role in Plastics Proliferation, accessible at: https://bit.ly/2ndRPW0

Our appetite for plastic is insatiable. One million plastic water bottles are bought around the world every minute and that number is expected to jump another 20% by 2021. Plastic may last for generations, but nearly half of all that is made becomes waste within four years, 40% has only a single use and 90% is not recycled. Up to 12 million tons of plastic litter could be entering the ocean every year and the amount is set to triple by 2025[19].

Plastic debris may be a modern scourge yet its versatility and benefits are unquestionable[20]. Over the last 50 years, it has fuelled the global economy, become the packaging material of choice and is used in a myriad of manufacturing processes. It is found in adhesives, paints and cosmetics, cars and electronics, cables, computers, dry-cleaning fluids, rocket fuel, roofs, tanks, insulation, toys, furniture and many construction materials. The durability and adaptability of this petrochemical product has made it the true child of the oil age.

PLASTIC DEBRIS MAY BE A MODERN SCOURGE YET ITS VERSATILITY AND BENEFITS ARE UNQUESTIONABLE

Most plastic is produced in rich countries[21], but the majority of pollution comes from the many countries that have poor or non-existent collection and recycling systems[22]. The result is not just ocean pollution but a tsunami of plastic litter clogging drains, causing floods and becoming ideal breeding grounds for mosquitoes[23,24]. Eight Asian and two African rivers, including the Yangtze, Indus, Nile and Ganges, are thought to transport nearly 80% of the world's microplastics to the world's oceans[25].

[19] EcoWatch (2017), 1 Million Plastic Bottles Bought Every Minute, That's Nearly 20,000 Every Second, accessible at: https://bit.ly/2slGAMX
[20] British Plastics Federation, accessed March 2019: https://www.bpf.co.uk/
[21] CIEL (2017), Fueling Plastics: New Research Details Fossil Fuel Role in Plastics Proliferation, accessible at https://bit.ly/2m4xZwt
[22] World Economic Forum (WEF) (2018), Asia's plastic problem is choking the world's oceans. Here's how to fix it, accessible at: https://bit.ly/2C7ReZJ
[23] The Star (2012), Rubbish in drains and rivers are the main cause of flooding, accessible at: https://bit.ly/2m4yg2t
[24] Edie Newsroom (2001), Bangladesh to ban plastic bags in capital city, accessible at: https://bit.ly/2nGyHjl
[25] Schmidt, C., et al. (2017). Export of plastic debris by rivers into the sea. Environmental science & technology, 51(21), 12246-12253.

The Chemical Connection

Plastics are made from a broad range of chemicals known as polymers which are 99% derived from the oil and gas industry. Synthetic, or man-made, chemicals are then added in the manufacturing process to this feedstock to give plastic qualities like strength, flexibility, durability, colour and transparency.

The combination of these polymers and added catalysts, stabilisers, pigments, flame retardants and solvents, results in a cocktail of contaminants which not only alter the nature of plastic but can leach as toxins into the air, water, food and potentially human body tissue.

Marine life has been widely seen to be devastated by large bits of floating plastic. Humans, however, are likely being increasingly exposed to micro and nano-sized plastic particles and beads. These are predicted to be consumed in food and drink; by absorbing them through the skin; and from potentially inhaling them. Whatever way, the result is the growing presence in the human body of toxic chemicals[26].

[26] Science Daily (2016). Microplastics - a cause for concern, accessible at: https://bit.ly/2nPzLCd

HUMANS, HOWEVER, ARE LIKELY BEING INCREASINGLY EXPOSED TO MICRO AND NANO-SIZED PLASTIC PARTICLES AND BEADS

Scientists know that microplastic particles can absorb or carry organic contaminants, such as PCBs, pesticides, flame retardants and hormone-disrupting compounds. But the risks they pose is unclear and not uniform. Some particles may pass quickly through the human body without releasing their toxins, others can accumulate in it but be harmless, more still may remain lodged in the body in dangerous concentrations. The most dangerous could be the smallest nano-particles which can enter cells[27].

What is certain is that many of the chemicals that are routinely used to make plastic are dangerous. Bisphenol A (BPA), a group called phthalates, and some of the brominated flame retardants, all of which are used to make household products and food packaging, are proven endocrine disruptors which can damage human health if ingested or inhaled[28,29].

[27] Galloway, T. S. (2015). Micro-and nano-plastics and human health. In Marine anthropogenic litter (pp. 343-366). Springer, Cham.
[28] Rubin, B. S. (2011). Bisphenol A: an endocrine disruptor with widespread exposure and multiple effects. The Journal of steroid biochemistry and molecular biology, 127(1-2), 27-34.
[29] Jurewicz, J., & Hanke, W. (2011). Exposure to phthalates: reproductive outcome and children health. A review of epidemiological studies. International journal of occupational medicine and environmental health, 24(2), 115-141.

Some of these toxicants have been linked to cancers and damage to the immune system. Others have been shown to travel across a mother's placenta and be particularly dangerous to young children. Many have been banned from use in baby bottles and children's toys. Others in regular use have been linked to the malformation of foetuses and adverse birth outcomes, as well as allergies and cardiovascular disease[30]. Many of the additives to plastics have been studied, but the hazards of minute plastic particles to humans are only slowly emerging.

The chemical properties of plastic are only part of the problem; the physical presence of microplastic particles might have problematic impacts, dependant on their size, shape, number and composition[31]. For example, smaller particles might penetrate membranes and move throughout the body. If they enter the circulation, they can imbalance our immune system, exposing us to infections and tumours. Particles might trigger molecular or cellular cascade effects, causing oxidation stress, DNA damage or inflammation, paving the way for other diseases[32,33,34].

Last but not least, microplastics may pose microbiological hazards[35,36,37]. They are covered in a thin biofilm that can harbour dangerous bacteria, which may thrive better on plastic materials than on natural substrates. In this way, microplastics can act like miniature transporters for pathogens into the body, potentially increase infection rates, or undermining the immune system and microbiome of the lungs and gut.

[30] Rubin, B. S. (2011). Bisphenol A: an endocrine disruptor with widespread exposure and multiple effects. The Journal of steroid biochemistry and molecular biology, 127(1-2), 27-34.
[31] Revel, M., et al. (2018). Micro (nano) plastics: A threat to human health?. Current Opinion in Environmental Science & Health, 1, 17-23.
[32] Wright, S. L., & Kelly, F. J. (2017). Plastic and human health: a micro issue?. Environmental science & technology, 51(12), 6634-6647.
[33] Vethaak, A. D., & Leslie, H. A. (2016). Plastic debris is a human health issue.
[34] Revel, M., et al. (2018). Micro (nano) plastics: A threat to human health?. Current Opinion in Environmental Science & Health, 1, 17-23.
[35] Vethaak, A. D., & Leslie, H. A. (2016). Plastic debris is a human health issue.
[36] Kirstein, I. V., et al. (2016). Dangerous hitchhikers? Evidence for potentially pathogenic Vibrio spp. on microplastic particles. Marine environmental research, 120, 1-8.
[37] Keswani, A., et al. (2016). Microbial hitchhikers on marine plastic debris: human exposure risks at bathing waters and beach environments. Marine environmental research, 118, 10-19.

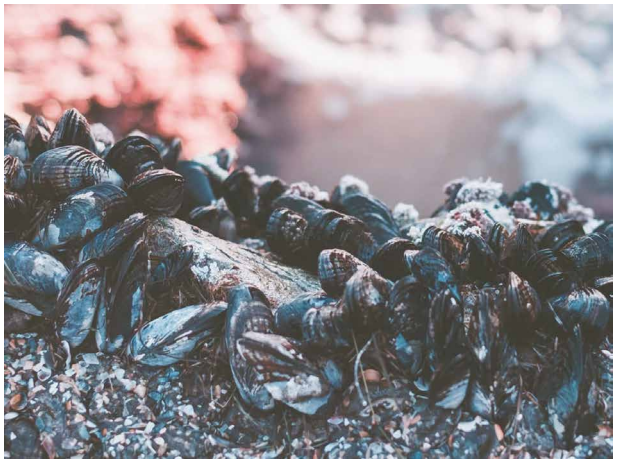
Microplastics have been reported in varying amounts in many species of seafood as well as in sea salt and drinks. There is growing concern that they might also be in honey, sugar and processed food. They can enter the food chain via water, contact with food packaging, air pollution in shops, homes and food factories[38].

Micro- and even smaller nano-plastics get into the human food chain via seafoods which for millions of people are essential to diets. Microplastics have been found in cod, mackerel, sea bass and more than a quarter of fish in markets in Indonesia and California[39].

But microplastics have been found in much larger quantities in many other marine organisms including zooplankton[40], crustaceans and shellfish. Concern is growing over the 22 million tonnes of bivalves which humans eat each year. These oysters, mussels, clams, shrimps and scallops use their gills to filter and capture tiny particles of food in the water such as phytoplankton, and so are in permanent contact with plastic-polluted water.

[38] Galloway, T. S. (2015). Micro-and nano-plastics and human health. In Marine anthropogenic litter (pp. 343-366). Springer, Cham.
[39] Rochman, C. M., et al. (2015). Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Scientific reports, 5, 14340.
[40] Cole, M., et al.. (2013). Microplastic ingestion by zooplankton. Environmental science & technology, 47(12), 6646-6655.

Belgian scientists recently calculated that shellfish lovers are eating up to 11,000 plastic fragments in their seafood each year[41]. In China, where much of the world's shellfish is farmed and eaten, and where much of the micro plastic pollution has been found, consumers are thought to ingest ten times as much[42].



Plastics can also contaminate the human food chain through constant exposure to the chemicals used in food packaging, building and household materials.

Many of the most widely used plastics in packaging contain a group of chemicals called Phthalates and BPA (bisphenol A). These key compounds of polycarbonate and polyester help soften plastics and make them transparent. BPA is used to make water bottles, coat the inside of food tins, line bottle tops, food trays and water pipes.

[41] Van Cauwenberghe, L., & Janssen, C. R. (2014). Microplastics in bivalves cultured for human consumption. Environmental pollution, 193, 65-70.
[42] Yang, D., et al.. (2015). Microplastic pollution in table salts from China. Environmental science & technology, 49(22), 13622-13627.

But researchers have shown how BPA and other chemicals have been detected widely in urine samples, leach into foods and are linked to asthma, attention-deficit hyperactivity disorder, breast cancer, obesity and type II diabetes[43,44].

Research is based largely on animal studies and no single study conclusively proves that BPA is harmful to humans[45,46,47] but the danger of people chronically poisoning themselves is taken seriously by some governments and many scientists[48]. The US National Toxicology Programme (NTP) says it has "some concern" for BPA's effects on the brain, behaviour, and prostate gland in foetuses, infants, and children[49]. It is still used widely in Britain in food containers.

Phthalates are a large class of chemicals that are widely used in shampoos, lipsticks, drugs, flooring, plasticisers, food packaging, toys, and cosmetics. Few have been fully studied, some have been banned and their cumulative toxic effect on humans is unknown. However, in the past few years, researchers have linked phthalates to asthma, attention-deficit hyperactivity disorder, breast cancer, obesity and type II diabetes, low IQ, neurodevelopmental issues, behavioural issues, autism spectrum disorders, altered reproductive development and male fertility issues[50].

The fear is that microplastic particles are carriers for other toxins to enter the body. Compounds containing toxic metals like mercury, organic pollutants including pesticides, and chemicals called dioxins, which cause cancer and reproductive and developmental problems, are known to bind to plastic microparticles[51]. These toxins may enter our bodies via other pathways, but microplastics may be an important transporter, contributing to their accumulation in fatty tissues.

[43] National Toxicology Program (2010), Bisphenol A (BPA), accessible at: https://bit.ly/2lGg9ja
[44] Biello, D. (2008). Plastic (not) fantastic: Food containers leach a potentially harmful chemical. Scientific American, 2.
[45] Magliano, D. J., & Lyons, J. G. (2013). Bisphenol A and diabetes, insulin resistance, cardiovascular disease and obesity: controversy in a (plastic) cup?. The Journal of Clinical Endocrinology & Metabolism, 98(2), 502-504.
[46] National Health Service (NHS) (2010), Questions raised over BPA plastic, accessible at: https://bit.ly/2ndAk8e
[47] Gao, X., & Wang, H. S. (2014). Impact of bisphenol A on the cardiovascular system—Epidemiological and experimental evidence and molecular mechanisms. International journal of environmental research and public health, 11(8), 8399-8413.
[48] Health Central (2014), Chemicals in food packaging may be harmful, https://bit.ly/2n7Ev5M
[49] National Institute of Environmental Health Sciences (NIH) (2008), NTP Speaks about BPA, accessible at: https://bit.ly/²mjKy⁴W
[50] Jurewicz, J., & Hanke, W. (2011). Exposure to phthalates: reproductive outcome and children health. A review of epidemiological studies. International journal of occupational medicine and environmental health, 24(2), 115-141.
[51] Jurewicz, J., & Hanke, W. (2011). Exposure to phthalates: reproductive outcome and children health. A review of epidemiological studies. International journal of occupational medicine and environmental health, 24(2), 115-141.

The River Tame in Manchester was found to contain 517,000 plastic particles of plastic per cubic metre of sediment, nearly double the highest concentration ever measured anywhere else in the world[52]. Yet the industrial river which flows into the Mersey and then the Irish Sea is widely thought to be one of the most ecologically improved in Britain, full of fish and inspected regularly by the Environment Agency.

Microplastic pollution is also turning up in freshwater everywhere around the world. Particles have been found in bottled and tap water, well water and 24 varieties of German beer[53]. The more researchers look, the more they are finding.

[52] Hurley, R., et al. (2018). Microplastic contamination of river beds significantly reduced by catchment-wide flooding. Nature Geoscience, 11(4), 251.
[53] Lachenmeier, D. et al. (2015). Microplastic identification in German beer-an artefact of laboratory contamination?. Deutsche Lebensmittel-Rundschau, 111(10), 437-440.

Several recent studies have shown drinking water to be contaminated with microplastics. In one, 11 globally sourced brands of bottled water, purchased in 19 locations in 9 different countries, were sampled. 93% were found to be contaminated, containing on average 325 microplastic particles per litre of bottled water.

A second study of 259 brands of bottled water taken from nine countries conducted by the State University of New York, found only 17 to be free of plastic[54]. The average number of particles was low, but the highest was nearly 10,000 plastic pieces per litre of water. Nor is tap water plastic free: another study estimated that people may consume 3-4,000 particles a year from tap water alone.

In all studies, the numbers of particles were relatively low compared with other forms of particle pollution such as is regularly found in urban air from diesel and petrol vehicles. But little is known about the cumulative, long-term impact of drinking microplastic contaminated water.

The danger of drinking plastic contaminated water has barely been assessed even though many people drink a bottle or more a day. The World Health Organisation has recently reviewed the scientific literature, emphasising the need for further research into microplastics exposure and potential health impacts[55].

A SECOND STUDY OF 259 BRANDS OF BOTTLED WATER TAKEN FROM NINE COUNTRIES CONDUCTED BY THE STATE UNIVERSITY OF NEW YORK, FOUND ONLY 17 TO BE FREE OF PLASTIC

[54] Orb Media, accessed March 2019 at: https://bit.ly/2GMSQg9
[55] World Health Organisation (2019), Microplastics in drinking-water. Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO

And The Air

Air pollution causes around 7 million premature deaths each year[56], but it is only recently becoming evident that air pollution might contain plastics, particularly from tyre wear, which could contribute to the global disease burden of particulate air pollution[57]. In 2016, a French study showed how a rain of microplastics regularly falls on Paris, dumping between three and 10 tonnes a year on the city, and potentially impacting people's health[58,59].

Microplastic air pollution is now known to come from both outdoor and indoor sources. Vehicle tyres, discarded litter and packaging, the dust produced when synthetic textiles are made, washed and dried, supermarkets and factories, and even the sewage sludge that is spread on fields as fertiliser, are all potential sources[60].

The clothes we wear are potentially hazardous. Nearly 16% of all the world's plastic production, or about 60m tonnes a year, goes to make synthetic textiles like Nylon, Polyester, and Spandex, which end up as the world's shirts, trousers, sports kit, carpets and upholstery.

[56] World Health Organisation (2019) Airpollution, accessed September 2019 at: https://bit.ly/2PwJeKO
[57] Kole, P. J., et al. (2017). Wear and tear of tyres: a stealthy source of microplastics in the environment. International journal of environmental research and public health, 14(10), 1265.
[58] Wright, S. L., & Kelly, F. J. (2017). Plastic and human health: a micro issue?. Environmental science & technology, 51(12), 6634-6647.
[59] Gasperi, J., et al.. (2015, September). First overview of microplastics in indoor and outdoor air.
[60] Gasperi, J., et al. (2018). Microplastics in air: Are we breathing it in?. Current Opinion in Environmental Science & Health, 1, 1-5.

The microplastic fibres shed from synthetic fabrics are different to most plastic. Production, which is increasing worldwide about 6% a year, involves the weaving together of minute threads with chemicals and dyes added to give the cloth colour and qualities like waterproofing, softness and elasticity[61]. Microplastic fibres (microfibres) are easily released into the air. Clothes can shed thousands of microplastic fibres at a time when being washed[62].

NEARLY 16% OF ALL THE WORLD'S PLASTIC PRODUCTION, OR ABOUT 60M TONNES A YEAR, GOES TO MAKE SYNTHETIC TEXTILES LIKE NYLON, POLYESTER, AND SPANDEX

Several studies suggest that we may be exposed to these fibrous microplastics both in the home and out of doors. Although exposure to microfiber pollution was found to be more serious indoors than outdoors, particularly for young children[63], outdoors pollution is also concerning, as nearly a third of all the fibres from atmospheric fallout outdoors contained petrochemicals[64].

[61] Gasperi, J., et al. (2018). Microplastics in air: Are we breathing it in?. Current Opinion in Environmental Science & Health, 1, 1-5.
[62] Browne, M. A., et al. (2011). Accumulation of microplastic on shorelines woldwide: sources and sinks. Environmental science & technology, 45(21), 9175-9179.
[63] Dris, R., et al.. (2017). A first overview of textile fibers, including microplastics, in indoor and outdoor environments. Environmental Pollution, 221, 453-458.
[64] Dris, R., et al. (2016). Synthetic fibers in atmospheric fallout: a source of microplastics in the environment?. Marine pollution bulletin, 104(1-2), 290-293.

The wastewater from washing machines has been found to release thousands of individual fibres from a single wash[65]. Depending on wastewater infrastructure, treatment plants may catch less than half of the fibres, so the chances of these plastic microfibres reaching the ocean are high[66].

Plastics are made with petroleum, so are particularly attractive as a fuel for burning. Millions of tonnes a year are collected and incinerated in rich countries to save recycling and provide heat. But burning plastic is also known to release harmful dioxins into the air. The industry claims that state-of-the-art plants filter out such toxic air pollution but this is disputed.

Burning plastic in the open, which is practised widely in parts of Asia and Africa, is particularly dangerous. In one Indian study, the burning of household waste was found to release dangerous dioxins, furans, mercury and polychlorinated biphenyls which have been linked to heart and respiratory diseases[67].

Scientists do not know exactly what might be a healthy level of airborne microplastics. But there is a risk that the smallest microparticles can be breathed in to the lungs, where they could potentially deliver chemicals to our lungs and possibly into our circulation, in the same way as diesel soot particles have been shown to be present in the bloodstream.

[65] Surfrider Foundation (2017), Plastic Microfibers: Recent Findings and Potential Solutions, accessible at: https://bit.ly/2EKx4UW
[66] Hartline, N. L., et al. (2016). Microfiber masses recovered from conventional machine washing of new or aged garments. Environmental science & technology, 50(21), 11532-11538.
[67] Verma, R., et al. (2016). Toxic pollutants from plastic waste-a review. Procedia Environmental Sciences, 35, 701-708.

The Gaps

The impacts of plastic particles in the food we eat and the air we breathe is an emerging concern. But the human health impacts are under-studied. More robust scientific evidence is needed to establish fully the risks and impacts of human exposure to microplastics and the chemicals they contain.

Research is also needed to understand better how the plastic particles might build up in lungs and in digestion systems, and what are acceptable doses and exposures to micro and nano-particles. More knowledge is needed about how plastic microparticle pollution compares to other sorts of pollution which may be inhaled or ingested.

Knowledge of the interaction of plastic particles with tissues and cells in humans is still poor but, based on the well-established Precautionary Principle, there is enough evidence about the risks to take action.

Conclusion

Plastic debris is one of the world's foremost environmental concerns, alongside climate change and habitat degradation. All life on earth, from ecosystems to people, are increasingly being exposed to plastic waste without knowledge of its full effect.

Plastic was first mass-produced in 1950 and by 2017 8.3 billion tonnes had been produced - this figure is projected to triple again by 2050. Since it is impossible to clean up, we can expect microplastic levels to rise as plastic production, use and disposal increases. The risks plastic pose to our health today are alarming when we consider the imminent increase in exposure.

National and international regulation has not kept pace either with the many different plastics which are flooding into the market, or with the vast quantities now being used.

Companies need to dramatically rethink the use, supply and recovery of plastics. Governments must regulate to radically reduce production and pollution, optimise recycling, and the development of safer alternatives. Scientists must be enabled to research more fully the health effects. Consumers must be made more aware of the potential hazards that our everyday plastics pose to the ocean, and to us.

[68] Barboza, L. G. A., et al.. (2018). Marine microplastic debris: An emerging issue for food security, food safety and human health. Marine pollution bulletin, 133, 336-348.

The Authors

John Vidal

John Vidal was the Guardian's environment editor. He joined the paper in 1995 after working for Agence France Presse, North Wales Newspapers, and the Cumberland News. He is the author of McLibel: Burger Culture on Trial (1998) and has contributed chapters to books on topics such as the Gulf war, new Europe, and development.

Jo Royle

Jo lives and breathes the ocean with 20 years' experience spearheading global marine programs. She focuses on identifying critical marine issues and aligning senior experts with engineering solutions to reduce human impact on the sea. A former trans-ocean sailing and skipper, she founded Common Seas to design out plastic pollution.

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