PLASTIC HEALTH
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Plastic and Human Health: alarming evidence

Plastic is Everywhere

Plastic has reached the deepest point in our oceans; it has been found on the peaks of the Himalayas, at both poles, and everywhere in-between. Hundreds of species are adversely affected by the plague of plastic. It destroys environments, chokes and injures animals, and exposes life to a variety of chemicals which impair bodily functions and cause health problems. Most studies available examine the effects of plastic on animals, but what about on humans? Plastic particles have been discovered in human feces[1], and its additives have been found in human breast milk[2]. We interact with plastic every day, often without realizing it – what does this mean for our health?

Routes of Human Exposure

Chronic exposure to plastic in humans is expected to be an issue of great concern to our health in the near future — from nanoplastics in cosmetics[3] and synthetic fibers in clothing[4], to plastic particles in water[5] and in the air[6]. We eat, breathe, drink, and wear plastic without having a clear idea of what it means for our health.

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[1] Microplastics Discovered In Human Stools Across The Globe In 'First Study Of Its Kind" (*www.umweltbundesamt.at Environment Agency Austria*, 2018) <http://www.umweltbundesamt.at/en/news_events_reports/news_eaa/en_news_2018/news_en_181023/> accessed 1 December 2018

[2] Mendonca, K., R. Hauser, A. M. Calafat, T. E. Arbuckle, and S. M. Duty (2014). "Bisphenol A concentrations in maternal breast milk and infant urine." *International archives of occupational and environmental health* 87, no. 1: 13-20.

[3] Leslie, H. A. (2014). Review of microplastics in cosmetics. *Institute for Environmental Studies [IVM]*.

[4] De Falco, F., Gullo, M. P., Gentile, G., Di Pace, E., Cocca, M., Gelabert, L., ... & Mossotti, R. (2017). Evaluation of microplastic release caused by textile washing processes of synthetic fabrics. *Environmental Pollution*.

[5] Tyree, C. and Morrison, D. (2018). *Plus Plastic - Microplastics Found in Global Bottled Water*. [online] Orbmedia.org. Available at: https://orbmedia.org/stories/plus-plastic/multimedia [Accessed 1 May 2018].

[6] Wright, S. L., & Kelly, F. J. (2017). Plastic and human health: a micro issue?. Environmental science & technology, 51(12), 6634-6647.

Evidence of human exposure to plastic particles through inhalation includes the presence of microplastics in atmospheric fallout (the most significant source overall), in sludge byproducts used for agricultural purposes, and in air pollution caused by the wearing out of rubber tires[6]. Microplastic fibers have been found in lung tissue, meaning that it is possible for them to enter the body despite mucociliary clearance channels[7]. These inhaled plastic fibers are extremely durable in physiological fluid; plastic fibers are likely to persist in the lung and build up over time. Studies among nylon fiber workers suggest that increased exposure to fibrous microplastics in the air is associated with respiratory irritation, interstitial lung disease, breathlessness, and reduced lung capacity[6].

Dietary exposure to plastic is perhaps the most widely recognized route of exposure by the public, even if air pollution is the most prevalent. Dietary exposure occurs through the consumption of shellfish (the most important dietary source) and other seafood and non-seafood such as honey, meat, and salt[6]. Humans even consume tiny plastic particles when we drink water; Orb Media recently demonstrated the presence of plastic in otherwise safe tap and bottled water around the world[8]. While plastic itself is considered inert, there are pathways through which microplastics could cause harm to our bodies through inflammation, genotoxicity, and oxidative stress, for example[6]. It is clear that humans consume plastics, but the impact thereof needs to be studied further.

As for plastic exposure through skin absorption, there is much that we don't know. What we do know is that most cosmetics, depending on the brand, contain some form of plastic, if not abrasive microbeads, then other forms of micro and nanoplastics. These cosmetics are everything from lipstick to sunscreen to body wash, mascara, and nail polish. The abundance of synthetic fibers in clothing furthermore raises questions about the extent to which these substances are absorbed into the skin and consequently the bloodstream. This field requires more research and is not to be overlooked.

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[7] Gasperi, J., Dris, R., Mirande-Bret, C., Mandin, C., Langlois, V., & Tassin, B. (2015). First overview of microplastics in indoor and outdoor air. In *15th EuCheMS International Conference on Chemistry and the Environment*.

[8] Tyree, C. and Morrison, D. (2018). *Plus Plastic - Microplastics Found in Global Bottled Water*. [online] Orbmedia.org. Available at: https://orbmedia.org/stories/plus-plastic/multimedia [Accessed 1 May 2018].

Nanoplastics

The presence of plastic nanoparticles was found to cause brain damage and behavioural abnormalities in fish in a 2017 study which marked the first observed cases of direct interactions between plastic nanoparticles and brain tissue[9]. Although the study was carried out on fish, the repercussions of human exposure to plastic particles must be better understood. The smallest of plastic particles may penetrate deeply into organ tissue[10], and the translocation of plastic particles from the gut to the lymphatic system has furthermore been observed in different species[11,12].

Additives to Plastic

Plastics contain chemical additives which give them various characteristics such as durability, plasticity, and stability in heat. Common among these chemicals are endocrine disrupting chemicals (EDCs), such as the notorious BPA. According to the World Health Organization, EDCs are associated with imbalances in sex ratios, disruption in fertility cycles and delayed or accelerated puberty in females, as well as delayed neurodevelopment in children, immune disorders, and hormone-related cancers[13].

Even low levels of exposure to endocrine disrupting chemicals are of concern to living organisms; experimental research on animals shows impaired thyroid and immune function, among other concerning side-effects[14]. The periods during which test subjects

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[9] Mattsson, K., Johnson, E. V., Malmendal, A., Linse, S., Hansson, L. A., & Cedervall, T. (2017). Brain damage and behavioural disorders in fish induced by plastic nanoparticles delivered through the food chain. *Scientific Reports*, *7*(1), 11452.

[10] EFSA Panel on Contaminants in the Food Chain (CONTAM). (2016). Presence of microplastics and nanoplastics in food, with particular focus on seafood. *EFSA Journal*, *14*(6), e04501.

[11] Browne M.A., Dissanayake A., Galloway T.S., Lowe D.M., Thompson R.C. (2008). Ingested Microscopic Plastic Translocates to the Circulatory System of the Mussel, Mytilus edulis (L.). *Environmental Science & Technology*, 42 (13), pp 5026–5031.

[12] Brennecke D., Ferreira E.C., Costa T.M., Appel D., da Gama B.A., Lenz M. (2015). Ingested microplastics (>100 um) are translocated to organs of the tropical fiddler crab Uca rapax. *Marine Pollution Bulletin* ; 96(1-2):491-5.

[13] Bergman, Å., Heindel, J. J., Jobling, S., Kidd, K., Zoeller, T. R., & World Health Organization. (2013). State of the science of endocrine disrupting chemicals 2012: summary for decision-makers

[14] Gallo, F., Fossi, C., Weber, R., Santillo, D., Sousa, J., Ingram, I., ... & Romano, D. (2018). Marine litter plastics and microplastics and their toxic chemicals components: the need for urgent preventive measures. *Environmental Sciences Europe*, *30*, 1-14.

were most susceptible to the effects of endocrine disrupting chemicals were the embryonic and early development stages. This suggests that the plastic and health problem concerns future generations, as exposure starts early.

Though public awareness of the dangers of some EDCs such as BPA has been on the rise in recent years, 'BPA Free' products are not as safe as they are purported to be. Studies have found that virtually all plastic items tested, even those advertised as 'BPA Free', contain chemical alternatives which similarly affect estrogenic activity[15]. Where there is no BPA, rest assured that you will find other chemicals, such as BPF for instance. BPF is commonly used as a coating for food and drink cans and in dental devices. In mice, it has been shown to lead to increases in anxiety and depression in offspring exposed in the womb[16].

Phthalates**,** another form of endocrine disrupting chemicals, are used in plastics to increase flexibility in plastic and are often referred to as plasticizers. They are also used as solvents and can be found in various products, ranging from vinyl on floors, to cosmetics and toys. Human exposure occurs mainly through diet, as phthalates can be released from packaging material into products. Phthalates are metabolized by the body and the metabolites usually pass out of the body through urine; phthalates are not known to bioaccumulate[17]. Despite this, some studies have observed associations with health effects such as altered semen quality and shortened gestation periods[18,19].

Brominated Flame Retardants (BFRs), used in plastics to fireproof electronics, synthetic foams and textiles, and plastic furniture, have also raised concern among scientists over

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[15] Yang, C. Z., Yaniger, S. I., Jordan, V. C., Klein, D. J., & Bittner, G. D. (2011). Most plastic products release estrogenic chemicals: a potential health problem that can be solved. *Environmental Health Perspectives*, *119*(7), 989.
[16] Ohtani, Naoko, Hidetomo Iwano, Koshi Suda, Erika Tsuji, Kentaro Tanemura, Hiroki Inoue, and Hiroshi Yokota. (2017). "Adverse effects of maternal exposure to bisphenol F on the anxiety-and depression-like behavior of offspring." *Journal of Veterinary Medical Science* 79, no. 2: 432-439.
[17] Centers for Disease Control and Prevention. National Biomonitoring Program - Factsheet Phthalates. http://www.cdc.gov/biomonitoring/Phthalates_FactSheet.html. (Last accessed on 03-09, 2013).
[18] Hauser, R., & Calafat, A. M. (2005). Phthalates and human health. *Occupational and environmental medicine*, *62*(11), 806-818.
[19] Meeker, J. D., Sathyanarayana, S., & Swan, S. H. (2009). Phthalates and other additives in plastics: human exposure and associated health outcomes. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *364*(1526), 2097-2113.

the past 20 years. The amount of BFRs in the environment and its biota have steadily been increasing, without much understanding as to their health implications[20]. Sensitive populations such as children are thought to be at higher risk of exposure, and some BFRs such as PBDE (polybrominated diphenyl ethers) have been found in human breast milk[21]. BFRs are believed to impair neurological behavior, developing immune systems, and thyroid hormones[22]. Once again, however, more research is needed.

The Bottom Line

With the increasing ubiquity of plastic in our lives, our lack of robust knowledge about what it does to our health is alarming. The dangers plastics pose to marine life are slowly coming to the attention of the public, but there is a missing link; if plastic affects life in the ocean so drastically, it must also impact human health. We interact with plastics without completely understanding what they mean for our planet, much less our own bodies. There is a plethora of scientific gaps which must be explored. An understanding of plastics, their additives, and the interaction they have with our bodies is critical, now more than ever.

[20] De Wit, C. A. (2002). An overview of brominated flame retardants in the environment. *Chemosphere*, *46*(5), 583-624.
[21] Birnbaum, L. S., & Staskal, D. F. (2004). Brominated flame retardants: cause for concern?. *Environmental health perspectives*, *112*(1), 9.
[22] Darnerud, P. O. (2003). Toxic effects of brominated flame retardants in man and in wildlife. *Environment international*, *29*(6), 841-853.