DOI:10.31557/APJEC.2023.6.1.81

REVIEW

Plastic and its Side Effects on Humans – A Review Article

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Abstract

Plastics are non-biodegradable synthetic substances produced by chemical reactions. Except few test resins derived from corn and other organic substances, almost all plastics are made from carbon and petroleum. The invention of plastics alterated our society by introducing a huge spreading of products and has displaced many traditional materials. We use plastic in countless ways in our daily life such as food storage containers, electric wiring, toys, furniture, clothes, injection, syringes water, and milk bottles, packaging and carry bags, pipes, electronic items, frames, and other several thousands of items. A polymer of carbon and hydrogen alone or with nitrogen, chlorine, oxygen, or sulfur is the backbone of the majority of plastics. Plastic is a non- biodegradable material. Plastic pollutes the air, earth, and water as they contain toxic chemicals. Ethylene oxide, benzene, and xylenes are highly toxic and these are the major chemicals that go into the making of plastic and cause a serious threat to living being of all species on earth. These chemicals can cause disorders ranging from birth defects to cancer, damage the nervous system and the immune system and also affect the blood and the kidneys. Also, many toxic gases are emitted during recycling of plastic. More than 100 million tons of plastic are produced worldwide each year. Plastics do not undergo bacterial decomposition and the disposal of plastic through recycling, burning, or landfilling is a fable. Plastic wastes clog the drains and thus hit especially urban sewage systems. The plastic contaminates the water, soil, marine life and also the air we breathe, causing countless problems to living organism.

Keywords: Plastic- Human Health- Pollution

Asian Pac Environ Cancer, **6 (1)**, 81-85

Submission Date: 01/19/2023 Acceptance Date: 03/21/2023

Introduction

Plastic is a synthetic substance and it is made from organic polymers such as polyethylene, PVC, nylon, etc. It can be manipulated into different shapes and can be prepared into rigid or flexible form [1]. The first man-made plastic was called 'Parkesine' derived from cellulose and it was created by Alexander Parkes who demonstrated it at the 1862 Great International Exhibition in London [2]. Almost all plastics are made from carbon and petroleum. We use plastic in countless ways in our daily life. Plastic is a non- biodegradable material. It pollutes the air, earth, and water and is composed of toxic chemicals [3]. Also, many toxic gases are emitted during recycling and burning of plastics. Humans can get cancer or other diseases like asthma, heart diseases, abnormal fetal brain development, reproductive disorder etc. on exposure to toxic components of plastics [4] (Table 1) [5].

There are three different kinds of plastics, according with the way in which their chains are bound, and so their properties differ

Elastomer

Any rubbery material composed of long chainlike molecules, or polymers, that are capable of recovering their original shape after being stretched to great extents—hence the name elastomer, from "elastic polymer." Under normal conditions the long molecules making up an elastomeric material are irregularly coiled. With the application of force, however, the molecules straighten out in the direction in which they are being pulled. Upon release, the molecules spontaneously return to their normal compact, random arrangement [6].

Thermoset or Thermosetting plastics

Once cooled and solid plastics keep their shapes and cannot reappear in their original form. They are hard and permanent. Thermoset can be used for auto parts aircraft

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parts and tires. E.g., Polyurethanes, polyurethanes, polyesters, epoxy resins and phenolic resins [6].

Thermoplastics

Less inflexible than thermoset thermoplastic can compose upon heating and reappear to their original form. They are easily manipulated and expelled into films, fibers. E.g.; polyethylene, polypropylene and polyvinyl chloride [6].

Polyethylene terephthalates (PET or PETE)

In 1941 John Rex Winfield, discovered polyethylene terephthalates. He condensed ethylene glycol with terephthalic acid the condensate was polyethylene terephthalate (PET or PETE). PET is the most important plastic in zip lock food storage bags. It is a thermoplastic that can be drawn into films (like Mylar) and fibers (like Dacron) [6].

High density polyethylene

HDPE is sometimes called "alkathene" or "polythene" when used for pipes. It is a polyethylene thermoplastic made from petroleum. HDPE is used in the formation of corrosion-resistant piping, plastic bottles, and geomembranes and with a high strength to-density ratio. HDPE is universally recycled and has the number "2" as its resin identification code [6].

Poly vinyl chloride (PVC)

PVC is a thermoplastic. It is molded when vinyl chloride polymerizes. it is soft and moldable. PVC is familiarly used for plumping because its stable can't be crumbled and is inexpensive than metal pipes. Over the long duration of time however, the plasticizer may leach out of it, rendering it brittle and breakable [6].

Polyethylene, LDPE and HDPE

The most familiar polymer in plastic is polyethylene which is made from ethylene monomers. The first polyethylene was made in 1934, it is also called low-density polyethylene because it swims in a mixture of alcohol and water. In LDPE, the polymer strands are entrapped and loosely arranged so it's soft and flexible. It was first treated to insulate electrical wires but now it's used to make films, wraps, bottles. disposable gloves and garbage bags. In the 1950 Karl Ziegler, polymerized ethylene in the presence of various metals. The resulting polyethylene polymers were composed of mainly linear form produced tighter thicker more organized structures and are now called high-density polyethylene (HDPE). HDPE is a denser plastic with a higher melting point than LDPE [6].

Polypropylene (PP)

In 1953 Karl Ziegler, produced independently polypropylene from propylene monomers and received the Nobel prize in chemistry in 1963. The various fashions of polypropylene have various melting points and hardness. Polypropylene is used in car trim, bottles, tubes, battery cases, filaments, and bags [6].

Polystyrene

A hard, stiff, brilliantly transparent synthetic resin produced by the polymerization of styrene. It is widely employed in the food-service industry as rigid trays and containers, disposable eating utensils, and foamed cups, plates, and bowls [6].

Other Plastics

Plastic 7 can be a little tricky as it stands for "Other" which may or may not contain BPA. It is commonly used to label Polycarbonate (PC). The letters PC may be present with the recycling symbol, which would indicate that the product is made with polycarbonate [6].

Microplastic

The small debris in the environment resulting from the disposal and breakdown of consumer products and industrial waste are microplastics [7]. They as less than 5mm in diameter as per the classification by National Oceanic and atmospheric administration (NOAA). Micro plastics can be primary microplastics or secondary microplastics. Primary micro plastics are manufactured and are a direct result of human materials and products use. Secondary microplastics are derived from the breakdown of larger plastic debris. Both types are identified to persist in the environment at high levels, especially in aquatic and

Table 1. Types of Plastics [5]

Type (Resin Identification Code)	Plastics	Common Uses	Safety
1	PET	Polyethylene Terephthalate – Fizzy drink bottles and oven-ready meal trays	Use with caution
2	HDPE	High Density Polyethylene – Bottles for milk and washing up liquids.	Safe choice
3	PVC	Polyvinyl Chloride – Food trays, cling film, bottle for squash, mineral water and shampoo	Avoid
4	LDPE	Low Density Polyethylene – Carrier bags and bin liners	Safe choice
5	PP	Polypropylene– Margarine tubs, microwaveable meal trays	Safe choice
6	PS	Polystyrene – Yoghurt pots, fish trays, boxes, wedding cups, protective packaging for electronic goods and toys	Avoid
7	OTHER	Any Other Plastics - an example is melamine, which is often used in plastic plates and cups.	Use with caution

marine ecosystem. Because plastic do not break down for many years, they can be ingested and accumulated in the bodies and tissue of many organisms [8].

Macro plastic

Macro plastic is clearly visible plastic (1-5 mm in size), and does not have a direct impact on the food chain. It floats in oceans like a soup and due to their size; it is directly or spontaneously entering into the food chain. Due to different processes such as hydrolysis, photo degradation or physical/mechanical degradation macroplastic degrades into microplastic [9].

Nano plastic

The breakdown process is not likely to stop at the micro level but will instead continue until the microplastic become small, nano sized plastic particle. All the microplastic derived from washing clothes or micro beads found in cosmetics might be further degraded to nano plastics. Despite their small size they have an enormous surface area bearing the potential to bind and even bigger number of toxic compounds than microplastics. Microplastics need to be consumed actively, whereas nano plastic might be absorbed spontaneously [9].

Plastic Pollution

In the environment, plastic accumulation oppositely favors wildlife or humans. Plastics that act as pollutants are categorized into micro-meso or macro debris based on size. Plastics are inexpensive and durable and as result, levels of plastic production by humans are high. Chemical structure of most plastics gives them resistant to many natural processes of degradation and as a result, they are slow to disgrace. These two factors have led to a high character of plastic pollution in the environment. Marine animals can be hurt either by the unreflective effect such as entanglement in a plastic object or problems related to ingestion of plastic waste or through exposure to a chemical within plastics [10].

Humans are also affected by plastic pollution such as through disruption of various hormonal mechanisms. In the UK alone more than 5 million tons of plastics are used each year of which only an estimated 24 % is recycled. In landfills, the remaining 3.8 million tons of waste is disposed. A large amount of plastic waste unavoidably enters the environment with studies suggesting that the bodies of 90% of seabirds contain plastic debris. Plastic pollution contributes to disease and cause acid rain. In some area, there have been suggestive efforts to lessen the plastic pollution through reducing plastic consumption and promoting plastic recycling. Plastic organic polymers with ultimately low reactivity towards the environmental factors thus have the power to remain intact for around 25,000 to 50,000 years on the earth without segregation [11].

Effect of Plastics on Animals

Plastic pollution has been described as being highly hurtful to large marine mammals. Some marine species such as sea turtles have been found to contain large number of plastics in their stomach. When this occurs, the animal is typically thin because the plastic block the animal's digestive tract. Marine mammals sometimes become entangled in a plastic product such as net which can harm or kill them. Entanglement in plastic debris has been liable for the death of many marine organisms such as fish, seals, turtles, and birds. These animals get caught in the debris and end up suffocating or engulfing because they are incapable to untangle themselves. Being entangled repeatedly result in severe shattering and ulcers. At least 267 different animal species have suffered from entanglement and ingestion of plastic debris, according to the 2006 report of plastic debris in the world's oceans [12].

Due to plastic pollution in the ocean, it has been estimated that over 400,000 marine mammals are destroyed annually. Marine organisms get caught in discarded fishing equipment such as ghost nets. Net and ropes used for fishing are made of synthetic material such as nylon making fishing equipment more durable and buoyant. These organisms get caught in a circular plastic material and if the animal proceeds to grow in size, the plastic can cut into their flesh. Equipment such as net can also drag along the seabed producing damage to coral reefs. Even planktons which are the smallest creatures in our oceans eat microplastic and swallow their hazardous chemicals [13].

Various chemical in plastics give them their rigidity or flexibility. The toxic chemical that leaches out of plastics an accumulate on other plastics. Toxic chemicals such as bisphenols phthalates, flame retardants, and another chemical are oily poisons that refuse water and adhere to petroleum-based objects like plastic debris. There is a serious concern with increasing number of plastic debris accumulating in the world oceans. Plastic bags are harmful when broken down naturally [14]. The broken-down elements cause sickness and destruction to the soil, air and water system. Oils are harmful and cause acid rain so the pollution gives to the disease-causing environment. Animals can eat it and it can be fragmented inside their body. Plasticizers can leach out of plastics and put into the death of plants and animals. If burned plastic can release various deadly or toxic chemicals into the atmosphere. It produces harmful gases such as carbon dioxide, sulfur dioxide, nitric oxide. These gases cause acid rain, which makes the lake acidic and causes fishes to die this gas also contribute to global warming [15].

Effect of Plastic on Human Health

The human health issue can occur with microbial ingestion and rapid toxicological effects associated with poisons produced in toxic algal blooms. This can produce a rapid decline in human health often resulting in ill health, hospitalization and sometimes death. Chemical contaminant effects are subtler, affording the potential for long-term bio-accumulative effects relating to genotoxins and endocrine disruption. Plastic factories are harmful as humans can get cancer or another disease like asthma. Chemicals such as BPA present have been linked to cancer, genetic changes, birth defects, ulcers and other serious problems [16].

The decomposition of polystyrene plastics vests a simple reality. Bisphenol A (BPA) has been shown and proven to interfere with the reproductive systems of animals. PS oligomer and BPA from plastic segregation are toxic and can be metabolized, while styrene monomer is a doubted carcinogen. Low levels of BPA and PS oligomer have been proven to cause hormone disruption in animals. In September 2008, Iain Lang and colleagues in the Journal of American Association published the first major study of health effects on humans associated with bisphenol A. The authors found that higher bisphenol A levels were significantly related to diabetes, heart diseases, and irregularly high levels of liver enzymes. A 2008 scientific review concluded that prenatal exposure to low doses of BPA alters breast development and increases breast cancer risk. The adverse effects of BPA on thyroid hormone action have very well been documented. BPA is produced in large amounts in each year. It leaches into food and water supplies, and humans are widely defenseless to it [17].

Reproductive disorders

Scientists from Brigham and Women's Hospital in 2013 announced that BPA exposure can affect egg maturation in humans. In 2015, it was detected that BPA can interfere with endocrine function involving the pituitary gland and the hypothalamus, which might lead to infertility and influence puberty and ovulation. It was reported that the detrimental effects on reproduction may be lifelong and transgenerational based on a study that considered the result of men's exposure to BPA at work. The finding suggested that high-level exposure may increase the risk of erectile dysfunction and problems with sexual desire and ejaculation [18].

Heart disease

Even low-dose BPA cause cardiovascular problems, containing heart attack, coronary artery heart disease, angina, peripheral artery disease, and hypertension. This type of exposure could trigger atherosclerosis arrhythmias, and blood pressure changes [19].

Type 2 diabetes and body weight

Low-level BPA could contribute to insulin resistance and diabetes type 2 occur. It may also influence body weight BPA suppressed the adiponectin hormone, which is the protein hormone secreted by fat cell and involved in regulating glucose level [20].

Fetal brain development

BPA has affected the developing brain during gestation. The impact includes changes in structural development, interference with estrogen regulation and DNA modifications. After birth, this could have effects on social behavior and anxiety [21].

Breast and prostate cancer

BPA is usually known as the estrogenic agent and could increase the risk of breast, prostate, and other cancers to people who were exposed to it in the womb. BPA could lead to the development of hormone-related cancers. BPA could interfere with the capability of chemotherapy in breast cancer treatment and binds to the same receptor as the female hormone does. BPA binds to estrogen receptors ER α and ER β, with a much lesser affinity than estradiol. BPA can interrupt with embryonic development and change ovarian cycle and exerts its role in many physiological and biological changes in women [22].

Asthma

BPA exposure increase the risk of wheezing and asthma, especially if it occurred during the age of 3, 5, and 7 years [23].

In conclusion, all form of plastic generates considerable environmental and financial burden. They consume growing amounts of energy and other natural resources, degrading the environment in several ways as well to using up fossil fuels and other resources. Plastic products create discompose, harm marine life. There are over 45 million tons of plastic produced per year a negligible fraction of which is getting recycled. All of us can take some steps to reverse the flow of toxic non-biodegradable pollution.

References

1. www.history of plastic.com/plastic-history/history-of-plastics/.
2. https://prezi.com/.../the-first-man-made-plastic-was-created-by-alexander-parkes-wll/.
3. Gautam AM, Caetano N. Study, design and analysis of sustainable alternatives to plastic takeaway cutlery and crockery. Energy Procedia. 2017;136:507-12.
4. Folkman J. Angiogenesis in cancer, vascular, rheumatoid and other disease. Nature Medicine. 1995 01;1(1):27-31. https://doi.org/10.1038/nm0195-27
5. Purhus KA, Kamstrup L.R, Lévová T, Didel JM, Engelbrechtsen M, Yusuf RO, Danesh MHS. Life Cycle Analysis of Steelcase Manufacturing. 2010.
6. Landrock, AH. Handbook of plastic foams: types, properties, manufacture and applications. Elsevier. 1995.
7. Andrady AL. Microplastics in the marine environment. Marine Pollution Bulletin. 2011 08;62(8):1596-1605. https://doi.org/10.1016/j.marpolbul.2011.05.030
8. Fendall LS, Sewell MA. Contributing to marine pollution by washing your face: microplastics in facial cleansers. Marine Pollution Bulletin. 2009 08;58(8):1225-1228. https://doi.org/10.1016/j.marpolbul.2009.04.025
9. Lusher A, Hernandez-Milian G, O'Brien J, Berrow S, O'Connor I, Officer R. Microplastic and macroplastic ingestion by a deep diving, oceanic cetacean: The True's beaked whale Mesoplodon mirus. Environmental Pollution. 2015 04 01;199:185-191. https://doi.org/10.1016/j.envpol.2015.01.023
10. Azzarello MY, Van Vleet ES. Marine birds and plastic pollution. Marine Ecology Progress Series. 1987;37:295-303.
11. Gregory MR. Environmental implications of plastic debris in marine settings--entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2009 07 27;364(1526):2013-2025. https://doi.org/10.1098/rstb.2008.0265

12. Furness RW. Birds as monitors of pollutants. In Birds as monitors of environmental change Springer, Dordrecht.. 1993;:86-143.
13. Sigler M. The effects of plastic pollution on aquatic wildlife: current situations and future solutions. Water, Air, & Soil Pollution, 225: 2184.. 2014;225:2184.
14. Derraik JGB. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin. 2002 09;44(9):842-852. https://doi.org/10.1016/s0025-326x(02)00220-5
15. Weston CJ, Attiwill PM. Clearfelling and burning effects on nitrogen mineralization and leaching in soils of old-age Eucalyptus regnans forests. Forest Ecology and Management. 1996 Dec 01;89(1):13-24. https://doi.org/10.1016/S0378-1127(96)03871-6
16. Thompson RC, Moore CJ, Saal FS, Swan SH. Plastics, the environment and human health: current consensus and future trends. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2009 07 27;364(1526):2153-2166. https://doi.org/10.1098/rstb.2009.0053
17. Vandenberg LN, Hauser R, Marcus M, Olea N, Welshons WV. Human exposure to bisphenol A (BPA). Reproductive Toxicology (Elmsford, N.Y.). 2007;24(2):139-177. https://doi.org/10.1016/j.reprotox.2007.07.010
18. Howdeshell KL, Hotchkiss AK, Thayer KA, Vandenbergh JG, Saal FS. Exposure to bisphenol A advances puberty. Nature. 1999 Oct 21;401(6755):763-764. https://doi.org/10.1038/44517
19. Melzer D, Rice NE, Lewis C, Henley WE, Galloway TS. Association of urinary bisphenol a concentration with heart disease: evidence from NHANES 2003/06. PloS One. 2010 01 13;5(1):e8673. https://doi.org/10.1371/journal.pone.0008673
20. Alonso-Magdalena P, Morimoto S, Ripoll C, Fuentes E, Nadal A. The estrogenic effect of bisphenol A disrupts pancreatic beta-cell function in vivo and induces insulin resistance. Environmental Health Perspectives. 2006 01;114(1):106-112. https://doi.org/10.1289/ehp.8451
21. Wolstenholme JT, Rissman EF, Connelly JJ. The role of Bisphenol A in shaping the brain, epigenome and behavior. Hormones and Behavior. 2011 03;59(3):296-305. https://doi.org/10.1016/j.yhbeh.2010.10.001
22. Nakaya M, Onda H, Sasaki K, Yukiyoshi A, Tachibana H, Yamada K. Effect of royal jelly on bisphenol A-induced proliferation of human breast cancer cells. Bioscience, Biotechnology, and Biochemistry. 2007 01;71(1):253-255. https://doi.org/10.1271/bbb.60453
23. Donohue KM, Miller RL, Perzanowski MS, Just AC, Arunajadai S, Hoepner LA, Canfield S, et al. Prenatal and postnatal bisphenol A exposure and asthma development among inner-city children. The Journal of Allergy and Clinical Immunology. 2013 03;131(3):736-742. https://doi.org/10.1016/j.jaci.2012.12.1573