Microplastic Ingestion from Marine Animals to Humans

HLTH 4310

Section 001

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Rationale

Since May 2021, I have been a pescatarian. A pescatarian is someone who only consumes fish and no other meats. I chose to become a pescatarian not only because it is healthier, but also due to noticing a healthier bodily change. Today, many people are becoming vegetarians as a result of what is put in the animals humans consume. A lot of the animals that people show concern about are land animals and how they are raised. I have recently begun to hear how some species of fish are not the safest to eat, and how farm raised and fresh fish are different in their health benefits. Wild-caught fish have been deemed healthier, however something I struggle with is finding fresh, wild-caught fish, such as salmon, in stores. Salmon is the main type of fish that I consume many times throughout the week. It is a reason why I am concerned about my health and what plastics may still be present in the fish at the time of consumption. My main focus will be on microplastic pollution in the ocean. Over thirty-five million tons of plastics were produced in 2018 with only three million tons being recycled (The Hill, 2022). This is a concerning statistic because with only a small amount of plastic being recycled, the majority of the thirty-five tons produced were most likely polluted after being used. Plastics make their way into the environment and into the ocean through pollution. I will research the process of how it is ingested by marine life and how humans can eventually ingest it along with the effects microplastics have on marine life and humans. Oceanic plastic pollution is a worldwide concern, and since I am a pescatarian, it affects me directly. If our planet is not being taken care of, then we are harming the animals that we consume, which means in the end that we are causing harm to ourselves.

Plastics Types and Amounts in Marine Life

Plastics vary in shape and size and over time the environment changes this. The plastic can break down into microplastics which are no bigger than five millimeters (Smith et al., 2018). Factors such as sunlight affect the degradation of plastics, turning them into microplastics (Smith et al., 2018). These microplastics eventually make their way into the marine animals that humans consume. Some specific types of plastics that are often found in the ocean are high density polyethylene, which would be a milk jug, and low density polyethylene such as a straw or plastic bag. Others consist of polypropylene like bottle caps, and polystyrene, which can be plastic utensils and food containers (Smith et al., 2018). Primary and secondary are the classifications of microplastics. Primary microplastics are smaller, while secondary microplastics are the breakdown product from products that are larger in size. About 4% of microplastics are made up of additives, which cause chemicals to bioaccumulate (Smith et al., 2018).

Plastic is a material that is persistent in the environment and there is a strong chance the plastics may bioaccumulate (McIlwraith et al., 2021). Microplastics in fish can translocate to the liver, fillet, and brain of the fish. A study was performed to examine the microplastics present in specific parts of the fish in Lake Simcoe, which is in Canada (McIlwraith et al., 2021). The goal of the study is to determine if the plastics are translocating, if there is a pattern, and if the plastics are bioaccumulating and biomagnifying. Of the sixty-nine fish collected there were seven species consisting of Smallmouth Bass, Largemouth Bass, Northern Pike, Yellow Perch, Brown Bullhead, White Sucker, and Lake Whitefish (McIlwraith et al., 2021). The gastrointestinal tract, fillet, and liver were the three parts of the fish that were examined. The study found every species of fish contained microplastics and 99% of the fish contained a type of plastic (McIlwraith et al., 2021). Another finding was that 56% of the plastic particles were anthropogenic, meaning they came from human pollution (McIlwraith et al., 2021). In the

gastrointestinal tract, fibers made up 94% of the plastics found, while fillets contained 37% of fibers and the liver contained 54% of fibers (McIlwraith et al., 2021). Foams made up the smallest percentage of plastics found in these three areas of the fish with no foam being found in the liver (McIlwraith et al., 2021).

The color of certain plastics is a significant factor that affects whether a fish will ingest it. In the study, "Microplastics in wild fish from North East Atlantic Ocean and its potential for causing neurotoxic effects, lipid oxidative damage, and human health risks associated with ingestion exposure," Barboza et al. (2020) states, the majority of the plastics found in the species D. labrax, T. trachurus, and S. colias were the color blue. Blue is also the color of the prey these species consume, which leads them to believing the plastic is food (Barboza et al., 2020).

One common substance in plastics that is found in marine life is polychlorinated biphenyls, or PCBs (Bhavsar et al., 2007). Research was conducted by the Sport Fish Contaminant Monitoring Program in Ontario, Canada in order to determine the amount of dioxin like PCBs in fish (Bhavsar et al., 2007). Fish from over 1700 different locations were collected from the end of summer to the beginning of fall (Bhavsar et al., 2007). There was an average of 23 spikes of PCB needing a minimum level of eleven for there to be a positive amount of PCBs (Bhavsar et al., 2007). The study found that dioxin like PCBs account for 8.5% of PCBs in fish (Bhavsar et al., 2007).

Microplastic Effects on Marine Life

A few of the health effects microplastics have on marine life are reproductive harms, blockages in the intestines, inflammation, and metabolic effects. The smaller the plastic, the worse the health effect will be (Almroth and Eggert, n.d.). Plastics vary in size, which is a factor in whether or not it can translocate to other parts of the fish. A particle the size of a nanometer

would likely have the ability to translocate (McIlwraith et al., 2021). Certain health problems such as inflammation can allow plastics to move across the body of the fish easily (McIlwraith et al., 2021). There are specific ways for plastics to enter the body of a fish. One way is through endocytosis and moving into the circulatory system (McIlwraith et al., 2021). Another route for plastics to enter fish is through paracellular diffusion, which is less common (McIlwraith et al., 2021). Plastics do not always have to be directly ingested, but they can be consumed as a result of a larger fish eating a smaller fish that has previously ingested plastic. In this scenario, the plastic continues up the food chain (Smith et.al., 2018).

Plastics affect the health of marine life in various ways. For instance, the blue crab will have respiratory problems as a result of ingesting microplastics and the effects on the Japanese medaka consist of hepatic tensions (Smith et.al., 2018). Another adverse health effect discussed in "Microplastics in wild fish from North East Atlantic Ocean and its potential for causing neurotoxic effects, lipid oxidative damage, and human health risks associated with ingestion exposure," occurs as a result of the plastic acting as food and giving the fish a feeling of satiation, which results in the fish eating less. This can cause intestinal problems and even the death of the fish (Barboza et al., 2020). If the gills are the area in which microplastics reside, it can result in the gill being damaged, causing respiratory problems and allowing more microplastics to accumulate here.

Human Plastic Ingestion and Health Effects

Seafood is understood to be healthy, but the risks associated with ingesting microplastics in seafood are often overlooked. In 2015, seafood made up 17% of animal protein consumption (Smith et al., 2018). United States seafood imports came from places that had an abundance of plastic pollution. Plastics are known to reside in the digestive tracts and gills of fish. It is more

likely that a human will ingest plastic when eating an entire smaller fish (Smith et al., 2018). When eating shellfish, humans consume nearly 11,000 plastic particles per year (Smith et al., 2018). These plastics have varying health effects on humans ranging from physical to chemical. Factors that determine how much of an impact the plastic ingestion will have on the person are size, additives in the plastics, susceptibility, and exposure (Smith et al., 2018). One example of how microplastics can be consumed by humans is through a mussel, oyster, or clam. These types of shellfish inhale and exhale water along with the microplastics that are in the water, which do not always get filtered out before being ingested by humans (Smith et al., 2018).

Humans can excrete over 90% of microplastics, but some are retained in the body (Smith et al., 2018). An investigation on microplastics in fish in the North East Atlantic Ocean and exposure risks to humans examined 150 fish from three species including, european seabass, the Atlantic horse mackerel, and Atlantic chub mackerel (Barboza et.al., 2020). The way human exposure was determined was by using the European Food Safety Authority weekly fish consumption recommendation. The weekly recommendations were 40 grams for one year olds, 50 grams for two to six year olds, 200 grams for children over the age of six, and 300 grams for adults (Barboza et.al., 2020).

The second way to measure exposure was using data from the European Market Observatory for Fisheries and Aquaculture Products, or EUMOFA, and the National Marine Fisheries Service, or NOAA (Barboza et.al., 2020). The EUMOFA and the NOAA determine the amount of fish consumed per capita. The countries focused on in the study were Portugal, Spain, Italy, the United States, and Brazil. Out of the 150 fish included in the study, seventy-three contained microplastics. Fifty-two of these fish contained microplastics in the gastrointestinal tract, fifty four fish were contaminated in their gills, and forty-eight fish had microplastic

contamination in the dorsal muscle (Barboza et.al., 2020). Each of the three species examined contained microplastics coming to a total of 368 pieces of microplastics (Barboza et.al., 2020). Out of the 368 pieces, 175 microplastics were found in the gastrointestinal tract, 112 pieces in the gills, and eighty-one pieces in the dorsal muscle (Barboza et.al., 2020). Looking at the amounts of microplastics in fish, it was found that children consume 112 microplastic pieces a year, while adults consume 824 microplastic pieces each year (Barboza et al., 2020). Looking from a perspective of seafood consumption per capita, the average amount of microplastics ingested are 518 to 3,078 pieces per year (Barboza et al., 2020).

Hwang et al. (2019) explains in the study, "An assessment of the toxicity of polypropylene microplastics in human derived cells," of fifty-six plastics found on the coast of Hawaii, forty-five were made up of polyethylene and the remaining eleven plastics were polypropylene. While plastics usually do not cause adverse effects in humans when ingested, the chemicals in the plastics do. Bisphenol A and phthalates are some chemicals that can harm humans through the endocrine system (Hwang et al., 2019). Secondary plastics are common in aquatic life, specifically polypropylene and polyethylene, which are focused on in the study (Hwang et al., 2019). Polypropylene plastics disrupt the immune system by affecting histamine which causes issues with allergies, and mental disorders such as schizophrenia, anxiety, depression, autism and behavior problems (Hwang et al., 2019). Different health effects were observed along with how polypropylene affects them. Polypropylene was tested with blood to examine if hemolysis was an effect. Hemolysis occurred at 2% only with larger polypropylene plastics and no hemolysis was observed with smaller particles (Hwang et al., 2019). Immune responses were monitored through cytokine release. The study found that particles smaller in size were seen as pathogens and caused inflammation, unlike larger particles, which had no effect

(Hwang et al., 2019). A histamine profiling test was conducted testing polypropylene plastics of different sizes. Varying sized plastics with a high amount of polypropylene initiated a histamine response (Hwang et al., 2019). In this situation it was examined that smaller plastics had a greater effect in causing an immune response such as inflammation in humans (Hwang et al., 2019).

Policies and Regulations

States across the United States have adopted bans on single-use plastics, like plastic bags as a result of the high amount of plastic pollution (Schultz, 2021). In the United States eight states, California, Connecticut, Delaware, Hawaii, Maine, New York, Oregon and Vermont, have banned these single-use plastics. California banned plastic bags in stores and passed a bill that enforces all plastic bags have a price of ten cents (Schultz, 2021). In New York however, counties can choose whether to charge a fee of five cents on plastic bags. New York also only bans plastic bags in grocery stores but not in restaurants. Other states focus on encouraging the act of recycling specifically near the coast, where there would be a greater impact (Schultz, 2021).

The Food and Drug Administration has set a 0.2 ppm limit for PCBs in infants and adolescents and a limit of 2 ppm for adults (Smith et.al., 2018). The Environmental Protection Agency concluded the reference dose, which is the amount that causes adverse effects in humans, for PAH is 0.0003 mg/kg/day (Smith et.al., 2018).

A policy known as extended producer responsibility has been put in place to make corporations and manufacturers responsible for the pollution of plastic packaging (Smith et.al., 2018). The Environmental Protection Agency's Trash Free Waters Program was put together to keep trash out of waterways and clean up trash currently in waterways. The Environmental

Protection Agency researches how trash impacts the marine environment, what causes the buildup of this pollution, and how to decrease risks (EPA, n.d.). One main risk that was researched was how microplastics would affect human health and environmental health. No regulations came out of the result of this study (EPA, n.d.).

Ocean Pollution Groups

Non-governmental organizations, or NGOs, are known for cleaning up plastics on beaches and making people aware of these implications to the marine environment (Smith et.al., 2018). The Ocean Conservancy is one of these non-governmental organizations that puts together the International Coastal Cleanup in seventy countries (Smith et.al., 2018). Another NGO is The Ocean Cleanup, which has a goal of cleaning up 90% of floating plastics by the year 2040 (Slat & Peytavin, 2022). In order to achieve this goal, they must remove all current plastics floating in the ocean and stop any new plastics from going into the ocean (Slat & Peytavin, 2022). There are multiple patches of plastic debris that spread across the ocean that the Ocean Cleanup organization works to eliminate by "creating an artificial coastline" using a U-shaped mechanism that captures the plastic (Slat & Peytavin, 2022). After the mechanism is full of plastics they are moved and sealed off, so no recontamination occurs and the plastics are later recycled (Slat & Peytavin, 2022). Another group, known as Ocean Recovery Alliance, explains their goal of creating programs to limit plastics in the ocean and on land by working with governments and communities. They educate and spread awareness in the community, nationally and internationally (Ocean Recovery Alliance, n.d.). Two major programs of the Ocean recovery Alliance organization are the Plastic Disclosure Project and the Global Alert platform. The Plastic Disclosure Project works to aid companies in being cautious with plastic use and how it is disposed of (Ocean Recovery Alliance, n.d.). The Global Alert platform focuses on floating trash

in the ocean, while working with communities to solve the problem. Global Alert shows a map of where there is floating ocean pollution and also allows communities to make others aware of plastic concerns in order to take steps to clean it up (Ocean Recovery Alliance, n.d.). Our Last Straw is an organization that focuses on the environmental effects of plastic straws and other single-use plastics by cooperating with restaurants, hotels, and other businesses in the District of Columbia area (Our Last Straw, n.d.).

Conclusion

Plastic pollution is a harmful problem that is present around the world. It is a problem that is becoming increasingly concerning. We must think of how plastic pollution will affect the future for humans and the planet. Plastics continue to be manufactured, but there are alternatives, such as paper and metal straws, reusable cups and reusable bags. Using these alternatives will decrease the amount of plastics in the ocean and as a result, marine life will be healthier. Consuming plastics and the chemicals associated with these plastics is not healthy, and it has the potential to harm not only fish but humans as well. Plastic bans and regulations are the start to developing a healthier plastic-pollution free environment.

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