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Effects of microplastics on the biological systems

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Abstract

Microplastics are the byproducts of the plastics that enter our lives in all areas such as health, food and drinking water, with various effects. The effects of exposure to microplastics on human health have been a matter of curiosity, and *in vivo* and *in vitro* studies have been conducted in this area. Considering the whole biological system, microplastics cause oxidative stress, inflammatory conditions, DNA breaks, chromosomal damages and genotoxicity in the cell. It can create inflammatory effects by affecting the immune system and trigger the formation of neoplasia. Further studies are needed to determine human exposure levels to microplastics and their association with chronic diseases. In our current proceeding review we are focusing on the microplastics and their effects on the cells.

Introduction

Microplastics have a size range of (MP) 1µm to 5 mm. They are created as a result of physical, chemical and mechanical decomposition of plastics with the effect of wind, ultraviolet, and water waves. With the increase in the plastic use in recent years, a significant increase has been observed in the amount of microplastics in the biosphere. MPs cause unfavorable impacts on the health of the organisms after being taken into the body with food and digested further to get into the organs, tissues and cells [1-2]. In recent studies, it has been reported that MPs are abundant in oceans and seas, drinking water, sea salt and products. It is thought to be the main component of the environmental pollution, as the most polystyrene microplastics are found in the environment [3]. Polystyrene is a type of plastic that is frequently used in the production of plastic-containing products and packaging [4]. Apart from polystyrene, polyethylene, polyethylene terephthalate, polyvinyl chloride and polypropylene are the plastic types that people are most frequently exposed to. Many studies have been conducted on the effects of MPs on the digestive system as well as, their cellular, chromosomal and cytotoxic effects.

Results

MPs have been found in the colectomy samples, lung tissue, circulation and stool, human placenta which have been investigated to have negative effects on the organismal health. Skin route might be another way of exposure to MPs, but studies supporting this are not available in the literature. Apart from the environmental exposure, it has been reported that medical prostheses containing plastic deteriorate over time and affect human health [5-7]. The cytotoxic effects of MPs on the cell basis were wondered, and it was noted that microplastics enter cells through endocytosis that eventually lead to the cytotoxicity [8].

In a study investigating the *in vivo* and *in vitro* effects of the polystyrene microplastics (1, 4 and 10 µm), it was reported that *in vivo* data did not show an inflammatory response on the tissue basis analysis. *In vivo* data suggested that MP had no histologically detectable lesions and inflammatory responses, and was even easily

digested by the macrophages. It has been reported that no cell activation or differentiation was observed after exposure of the human macrophage cell line THP1 with polystyrene [9].

The effects of polyethylene, polyethylene terephthalate, polyvinyl chloride and polypropylene, which we are exposed to through foods, were studied on the Caco-2, the human intestinal cells. Since the intestine is the first organ to be affected by the cytotoxicity of orally ingested microparticles, studying the colon cells would be informative about the effects of the MPs. As a result of the study, it was reported that Polyethylene microparticles (PEM) of 1-4 μm were transported significantly to the intestinal epithelium. Microplastic varieties have been reported to cause cytotoxic effects at high concentrations [10]. PEMs are thought to be in the clastogen potential to cause DNA strand breaks by causing abnormalities in DNA double strand break repair [11]. In addition, it has been determined that it has anogenic effect by causing defects in the chromosome separation in the anaphase stage. It has also been proven that chromosome kinetochores fail to attach to the spindle fibers during mitosis in the presence of MPs [12-13].

MPs (10–45 μm), which are not small enough to enter the cell nucleus, cause oxidative stress by disrupting the chemical reactions in the cells when they come into contact with the cell membrane, and as a result, they produce reactive oxygen species (ROS) [14]. Poma et al. reported that polystyrene microplastics increased ROS production in the Hs27 fibroblast cell line [15]. In a recent study, it was indicated that microplastics cause physical injury to the cell and cause a biochemical response, resulting in the inflammatory lesions [16].

Conclusion

In recent years, microplastics that we use and are exposed to in all areas of our lives have been investigated at molecular and cellular levels. They can cause molecular and cellular damage and cause genomic abnormalities that eventually lead to cancer and various other chronic diseases. *In vitro* and *in vivo* studies have been carried out to determine the effects of microplastics, and according to their results, cellular damage occurs depending on the MP type, concentration and exposure time. The results will be clearer if the studies conducted increase the sample size for the MP exposure to determine the defects on the chromosomes and DNA structure. More studies should be done to determine the human exposure levels to the MPs and their relationship to the chronic diseases.

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