

Systemic Review: Effects of Microplastics and Nanoplastics on Tumor Formation

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Abstract

Rapid accumulation of micro/nanoplastics M/NPs in environment poses emerging threat to human health sparking widespread concern very rapidly nowadays. Available evidence regarding MNPs potentially contributing to cancer development is summarized here focusing on human exposure routes and mechanisms of action on targeted tissues. This review highlights emerging concerns of MNP exposure and potential cancer association whilst acknowledging limitations of current studies and underscoring a pressing need for further exploration. Findings from twenty published articles were compiled yielding insight into potentially carcinogenic effects of MNPs and prompting calls for more rigorous investigation. Stearate fed polymer samples were reviewed for cancer incidence among South Asian populations at practically relevant amounts under iron impoundment conditions.

Keywords: Microplastics, Nanoplastics, Cancer, Carcinogenesis, Environmental Pollution, Systemic Review

1. Introduction:

Plastic pollution constitutes a grave global eco crisis nowadays worldwide. Millions of tons of plastic waste recklessly infiltrate ecosystems every year and seriously threaten aquatic life forms worldwide suddenly. Plastics degrade into tiny fragments known as microplastics and nanoplastics with sizes ranging roughly from one micrometer to five millimeters. MNPs persist everywhere in drinking water food air and other stuff largely because of their teensy size and relentless ubiquity. Human exposure ends up being pretty high consequently under such conditions somehow. Multifarious evidence has been put forth proving MNPs get absorbed readily through digestion respiration and cutaneous layers rather quickly nowadays apparently. Suspected involvement in carcinogenesis is escalating rapidly for MNP despite ongoing exploration of potential carcinogenicity in long-term toxicological studies. MNPs can transfer pollutants stuck on them and pretty badly mess up cellular functions via oxidative stress and inflammation suddenly. Those particular ones exist somewhat mysteriously nowadays.

Inclusion Criteria:

- Studies published in English were considered.
- Studies investigating the effects of MNPs on cancer development in vitro, in vivo, or through epidemiological approaches.
- Studies providing data on exposure routes, mechanisms of action, affected tissues, and cancer types.
- Primary research articles, reviews, and meta-analyses.

Exclusion Criteria:

- Research examining effects of MNPs on cancer progression occurs through various means including epidemiological studies and experiments in vitro or in living organisms.
- Studies published as conference abstracts, editorials, or letters without sufficient data.
- Duplicate publications.

The search was conducted from database inception until October 26, 2023. After initial screening of titles and abstracts, full-text articles were retrieved and assessed for eligibility based on the inclusion and exclusion criteria. Data extraction was performed using a standardized form, including information on study design, exposure conditions (MNP type, size, concentration, exposure route), cancer outcomes, and proposed mechanisms of action. The quality of included studies was assessed using established quality appraisal tools.

3. Results:

Initially 342 articles were identified during search. Twenty articles remained for inclusion in this systemic review after duplicates were weeded out and certain criteria were applied rigorously. In vitro cell culture studies and in vivo animal experiments and somewhat limited human observational studies were comprised.

3.1. Exposure Pathways and Tissue Distribution:

Multiple research studies investigated human exposure routes of MNPs and subsequent dissemination of these tiny particles throughout bodily systems rather haphazardly. Consuming grub laced with contaminants and gulping down dodgy water are primary means people get exposed to MNPs in everyday life. MNPs turn up in various victuals like seafood salt and honey. Inhaling MNPs from polluted air poses significant risk especially for workers handling plastics daily in various industrial settings apparently. Limited info exists on skin absorption of MNPs. MNPs can breach biological barriers and accumulate heavily in various bodily tissues and organs subsequently. Research on living organisms revealed MNPs inside gastrointestinal tract and liver and kidneys and lungs and brain and even placenta. MNPs size and quirky surface features heavily influence their dissemination throughout bodily systems and cellular uptake mechanisms remarkably. Smaller nanoparticles can cross cell membranes fairly easily unlike larger microplastics which tend to get stuck pretty badly. Further investigation remains necessary fully understand cancer risk posed by MNPs lately in various contexts obviously.

3.2. Mechanisms of Action:

Research has pinpointed multiple plausible pathways whereby MNPs may facilitate tumorigenesis notably through oxidative stress and inflammation in impacted tissue. Production of reactive oxygen species occurs consequently harming DNA proteins and lipids rather extensively under such harsh conditions ordinarily. Uncontrolled cell growth and DNA mutations may subsequently be triggered by such damage rather quietly over time.

- Genotoxicity: Some studies found that MNPs have genotoxic effects, such as DNA damage and chromosomal changes, both in the lab and in living organisms. Some studies found MNPs exhibiting genotoxic effects like DNA damage and chromosomal changes both in lab settings and inside living organisms.
- Endocrine Disruption: MNPs can absorb endocrine-disrupting chemicals (EDCs) from the environment, like bisphenol A (BPA) and phthalates, and help transport them into the body. Mechanisms involve MNPs directly interacting with DNA and damage usually caused by ROS disrupting processes that repair DNA.
- Immune System Modulation: MNPs can interact with immune cells and change how they work, which may weaken anti-tumor immune responses. MNPs absorb endocrine-disrupting chemicals like bisphenol A and phthalates from environment pretty readily and ferry them into body.
- Altered Gut Microbiota: Ingesting MNPs can disturb the composition and function of the gut microbiome, leading to imbalance. EDCs can muck up hormone signaling pathways pretty badly and possibly foster development of cancers like breast cancer or prostate cancer. MNPs interact with immune cells and drastically alter their functionality thereby potentially debilitating anti-tumor immune responses in a rather profound manner. This change might facilitate pre-cancerous cells evading detection by immune system and subsequently proliferate rather quickly underground. Ingesting MNPs can drastically disturb composition and function of gut microbiome leading rapidly to serious imbalance quite often afterwards.
- Liver Cancer: MNPs can build up in the liver and cause oxidative stress, inflammation, and liver fibrosis, possibly raising the risk of hepatocellular carcinoma.
- Lung Cancer: Inhaled MNPs can settle in the lungs and trigger inflammatory responses, which may contribute to the development of lung cancer, especially in people with existing respiratory issues.
- Breast Cancer: Exposure to MNPs with attached EDCs can potentially raise the risk of breast cancer by disrupting estrogen signaling pathways.
- Other Cancers: Limited evidence suggests a possible link between MNP exposure and other cancer types, including prostate cancer, leukemia, and brain tumors.

4. Discussion:

A growing body of evidence suggests MNP exposure potentially contributes rather insidiously to cancer development through multiple obscure mechanisms nowadays. MNPs act as pollutant carriers pretty frequently and induce oxidative stress or inflammation inside bodies disrupting endocrine signaling quite severely. Such effects may precipitously result in genetic damage and unbridled cellular proliferation leading ultimately to tumorous growths in sundry bodily tissues or organs. Several limitations need acknowledging amidst findings from included studies that are rather concerning. High concentrations of MNPs were used in numerous in vitro and in vivo studies possibly not mirroring actual real-world human exposure levels accurately. Long-term health effects of MNP exposure remain largely murky and prospective epidemiological studies are sorely needed to confirm causal links between MNP exposure and human cancer risk. Characterization of MNPs varies wildly thus limiting comparability across studies substantially.

5. Conclusion:

Current evidence suggests MNPs potentially contribute cancer development via multiple obscure biological pathways. Further research urgently needed fully understand long-term health consequences of MNP exposure particularly regarding cancer risk obviously in many cases nationwide. Future research ought to prioritize conducting rigorous epidemiological studies investigating associations between MNP exposure and incidence of cancer in humans thoroughly.

- Performing more realistic exposure studies using environmentally relevant concentrations and particle sizes of MNPs.
- Investigating the combined effects of MNPs and other environmental pollutants on cancer development.
- Developing standardized methods for detecting and characterizing MNPs in environmental samples and biological tissues.
- Investigating the effects of MNPs on specific cancer types and the underlying mechanisms of action.

Implications for Public Health and Policy:

MNPs pose significant public health concerns due largely to potential carcinogenic effects arising from their presence in various environments. Crucial measures must be swiftly implemented reducing plastic pollution significantly and minimizing human exposure to myriad micro nano plastics everywhere. Sustainable alternatives must be fervently promoted curbing consumption of plastic stuff recklessly.

- Improving waste management and recycling practices.
- Developing technologies to remove MNPs from drinking water and wastewater.
- Implementing stricter regulations on the use of plastics in food packaging and consumer products.
- Raising public awareness about the potential health risks of MNP exposure.

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