



Review

Dedicated to the memory of
Academician Bogdan C. Simionescu (1948–2024)

ARE MICROPLASTIC PARTICLES IN OUR EVERYDAY LIFE? HIDDEN SOURCES AND ACCESSIBLE SOLUTIONS—SYSTEMATIC REVIEW

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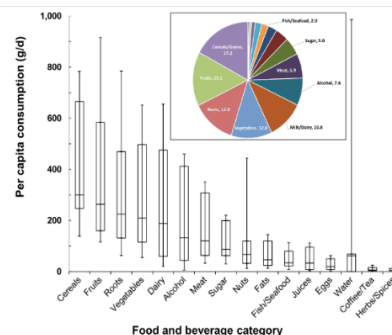
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Due to the ubiquity of microplastic particles (Mps) in everyday life, they pose a growing risk to both human health and the environment. In this study, we examined the often-overlooked sources of Mps in widely used articles using a variety of case studies while assessing the effects on the environment and human health, as well as providing viable ways to reduce exposure. We systematically reviewed data from international environmental groups, government papers, and scientific publications as part of the research. Our results show how Mps end up in the human body, their main hidden sources, in everyday objects, and their harmful effects, including oxidative stress, cellular toxicity, and possible endocrine disruption. Our study also looks at how Mps affect ecosystems, including how they contaminate soil, water, and air. We also provide suggestions and viable ways to reduce human exposure and provide policymakers with specific actions to take to combat this invisible pollution. Our results highlight the need for stricter laws governing plastic use, encouraging sustainable alternatives, and more consumer education. This research helps raise public awareness, provides practical methods to prevent Mps pollution by uncovering the hidden causes, and offers viable solutions at the same time.



INTRODUCTION

In recent years, Mps have become a major global concern, being detected in oceans, freshwater^{1–3} soil,^{4,5} food⁶, and the human body.⁷ These tiny particles, smaller than 5 mm in size,⁸ come from the breakdown of larger plastic waste, from cosmetics, or the wear and tear of everyday objects such as synthetic textiles.⁹ While the ecological impact of Mps on marine life is well documented, recent

studies suggest that human exposure to these particles could have adverse health effects,¹⁰ including hormonal disruptions and chronic inflammation.¹¹ Despite international efforts to reduce plastic use¹² (Fig. 1), Mps remains a ubiquitous presence in our daily lives. From the clothes we wear to the water we drink, these invisible particles constantly surround us. Thus, it is essential to understand the hidden sources of Mps and identify accessible solutions to minimize exposure.

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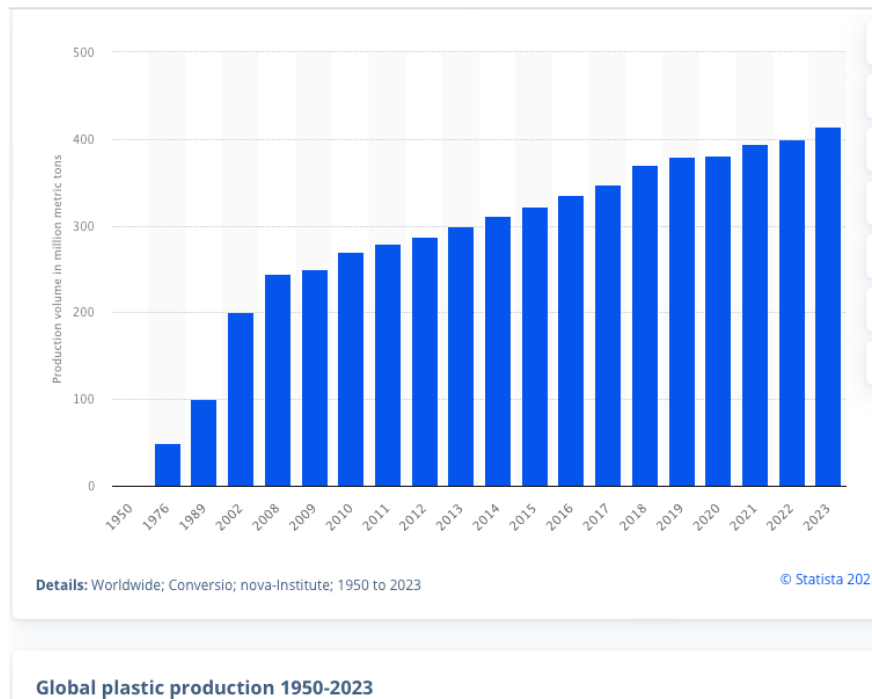


Fig. 1 – Global plastic production.¹³

Studies on Mps in Roumania are still in their infancy, but concerns about this form of pollution have begun to gain attention in recent years.¹⁴ Even though research is limited compared to other developed European countries, there is already evidence that Mps are present in water, soil, and even in the food consumed by the population. Roumanian rivers and lakes, especially those near urban and industrial areas, have been identified as significant sources of Mps pollution, and some preliminary studies have found plastic particles in water and sediment. The impact of Mps on local fauna is also an emerging concern, with significant risks for aquatic biodiversity and ecosystem health.¹⁵

Another very important environmental factor for human health is air. The air we breathe is increasingly contaminated with particulate matter (PM10 and PM2.5) and Mps.¹⁶ These come from various sources, such as tire abrasion, plastic degradation, or even textile fibers or industrial emissions released into the atmosphere.¹⁷ Once airborne, Mps can travel long distances and be inhaled, potentially, causing respiratory irritation, inflammation, and other health risks.¹⁸ Studies suggest that prolonged exposure to airborne Mps may contribute to oxidative stress and lung damage, raising concerns about their long-term effects on human health.¹⁹ In Roumania, air pollution is already a significant issue, especially in urban and industrial areas, where high levels of PM2.5 have been

recorded.²⁰ The presence of Mps in the air adds another layer of complexity to air quality concerns, emphasizing the need for stronger environmental policies, improved waste management, and public awareness to reduce plastic pollution and its airborne impact.

Few studies conducted in Roumania are also based on public perception of this risk,¹⁸ compared to other developed countries.²¹ Although there are recent initiatives to monitor this pollution, including collaborations between environmental organizations and academic institutions, Roumania faces a lack of data and clear policies in the field. Thus, further research and the development of legislative measures are essential to better understand the problem and take appropriate measures to combat Mps pollution.

This study aims to address the growing global concern regarding the impact of Mps on both the environment and human health. These pervasive pollutants threaten biodiversity, disrupt ecosystem balance, and accumulate in the human body, raising significant health risks. Mps contaminate all environmental factors, infiltrating air, water, and soil, and ultimately entering the food chain, thereby affecting the overall quality of life. Therefore, the objectives of this research are, first, to uncover lesser-known sources of Mps pollution while examining their effects on human health, food safety, and everyday household items. Additionally, it aims to deepen our understanding of the risks associated

with Mps exposure and to develop effective strategies for minimizing their environmental and health impacts. Through this approach, the study contributes to raising awareness and fostering actionable solutions to combat Mps pollution.

METHODOLOGY

To analyze the presence of Mps in everyday life, our study employed an experimental documentary approach, focusing on identifying hidden sources in commonly used products and evaluating accessible solutions to reduce exposure and promote sustainable alternatives. To ensure a comprehensive understanding of this issue, we conducted a systematic review of recent studies, complemented by an in-depth analysis of various case studies that illustrate real-world instances of Mps contamination and mitigation efforts.

Our sources included peer-reviewed articles published in indexed scientific journals, government reports, and data from international environmental organizations. By examining diverse case studies, we gained insight into how Mps infiltrate daily life, the pathways through which they reach the human body, and the broader implications for environmental and human health. This approach not only provided a clearer assessment of Mps hidden sources but also strengthened the scientific basis for our proposed recommendations.

Through the analysis of specialized literature and real-world examples, we identified the main sources of Mps in everyday environments, highlighting their harmful effects on ecosystems such as contamination of water, soil, and air and their potential health risks, including oxidative stress, cellular toxicity, and endocrine disruption due to the accumulation of plastic particles in the body. By integrating multiple perspectives, this methodology enhances awareness of this invisible pollution and supports the development of effective strategies to mitigate its impact.

RESULTS

Hidden sources of microplastics in everyday life

Mps are ubiquitous in the environment, but many of their sources remain unknown to the average consumer. Some of the most significant hidden sources include personal care products,

synthetic clothing, and food packaging. Even in ordinary households, these tiny particles are constantly being released, contributing to environmental pollution and unintentional human exposure to plastic. A major example of a hidden source is cosmetics and personal care products, such as exfoliating scrubs, toothpaste, and shower gels, which often contain Mps in the form of abrasive microparticles or thickeners. These tiny particles, known as microbeads, are used to give the products an abrasive texture, but they end up in sewage systems and ultimately in the aquatic environment, where they cannot be completely filtered out by wastewater treatment plants. Thus, they contribute significantly to water pollution and affect marine biodiversity, entering the food chain and reaching the final consumers.

Another important, lesser-known contributor is clothing made from synthetic fibers such as polyester, acrylic, and nylon. With each wash, these materials release significant amounts of plastic microfibers into the water, which are too small to be captured by conventional filtration systems. Studies show that a single load of laundry can release hundreds of thousands of microfibers into wastewater systems. These microfibers subsequently end up in rivers and oceans, where they are ingested by aquatic organisms.²² At the same time, they can remain suspended in the air in homes, being inhaled and posing a potential risk to human respiratory health. Plastic food packaging, especially that used for hot or fatty products, is another insidious source of Mps. Exposure to high temperatures and certain chemicals in food can cause plastic particles to migrate into food without being visible to the naked eye. Single-use plastic packaging, such as fast-food containers or plastic wrap used to wrap fresh produce, is responsible for continuous and difficult-to-avoid exposure. In the long term, consuming food contaminated with Mps can have negative effects on human health, from accumulation in internal organs to possible hormonal imbalances.

Impact on human health

According to Saha,²³ Mps has been detected in drinking water, food (Fig. 2), and even the air we breathe,²⁴⁻²⁶ raising major concerns about their effects on human health. Once ingested or inhaled, these particles can enter the digestive system²⁷ and possibly the bloodstream, with the potential to damage cells and alter immune system functions.²⁸ Recent studies suggest that Mps can act as vectors

for toxic substances and pathogens, amplifying the risks associated²⁹ with prolonged exposure. In addition, research indicates that the accumulation of these particles in the body can lead to inflammation, oxidative stress, and hormonal imbalances, being associated with an increased risk of cardiovascular

disease³⁰ and metabolic disorders. Although the global impact of Mps on human health is not yet fully understood, preliminary results highlight the need for in-depth studies to fully understand the long-term consequences of this invisible form of pollution.

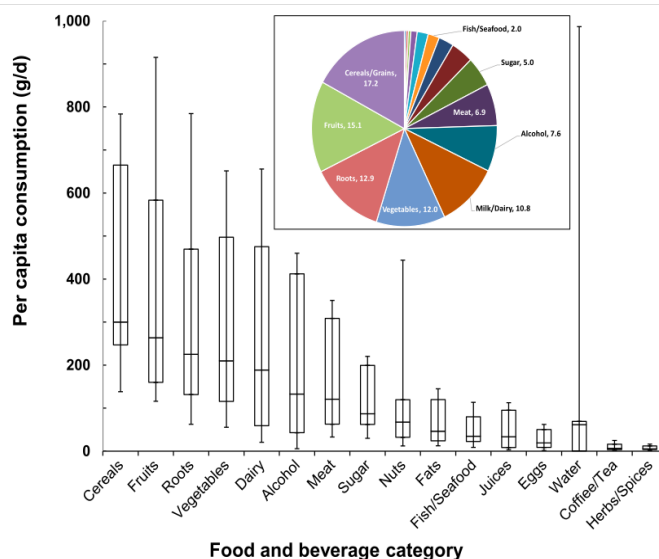


Fig. 2 – Dietary consumption from 16 food categories derived from all 17 GEMS/Food clusters.³¹

Environmental impact

Mps pose a significant threat to the environment, being present in soil,²⁶ water, and air,³² where they persist for a long time due to extremely slow degradation. In aquatic ecosystems, these particles are ingested by marine organisms, affecting the food chain and endangering biodiversity.³³ Studies have shown that Mps can cause internal injuries, reduced reproductive rates, and metabolic imbalances in fish, crustaceans, and other aquatic life. Moreover, these particles act as vectors for dangerous chemical pollutants, including heavy metals and toxic organic substances, amplifying the negative effects on ecosystems. In the terrestrial environment, Mps affects soil fertility and its microbiome, indirectly influencing the health of plants and crops. As these particles accumulate in nature, their impact becomes increasingly difficult to control, highlighting the need for urgent measures³⁴ to reduce plastic pollution and protect the environment.³⁵

Affordable solutions to reduce microplastic exposure

Reducing exposure to Mps requires both individual changes and collective action to reduce plastic

pollution.³⁵ An essential first step is to avoid single-use plastic containers³⁶ and utensils, opting instead for sustainable alternatives such as glass, stainless steel, or bamboo. Also, drinking filtered water instead of bottled water can significantly reduce the ingestion of plastic particles from packaging. Choosing clothes made from natural fibers, such as cotton or wool, instead of synthetic ones helps reduce plastic microfibers released during washing, and using a special filter for your washing machine can prevent them from entering wastewater.³⁷ In the kitchen, avoiding heating food in plastic containers and reducing the use of plastic wrap are simple but effective measures to limit food contamination with Mps. Collectively, promoting proper recycling, participating in greening campaigns, and supporting initiatives to reduce plastic use play a crucial role in combating this invisible form of pollution.³⁸ By adopting these measures, exposure to Mps can be significantly reduced, thus protecting both human health and the environment.

Recommendations for decision-makers

Among some recommendations for decision-makers that could help combat Mps pollution, we could mention:

- Implementing stricter policies and regulations on reducing the use of single-use plastics and encouraging environmentally friendly alternatives, such as biodegradable or reusable materials, worldwide, would contribute to significantly reducing the sources of Mps.
- Supporting and funding scientific research that analyzes the presence of Mps in various environments such as water, food, soil, etc., and their impact on public health and biodiversity is essential to understanding the phenomenon better and developing effective solutions.
- Introducing educational programs and awareness campaigns on the risks of Mps and how each individual can contribute to reducing exposure, such as choosing plastic-free products or using Mps filters. Surveys could be the first factors that could help with the perception of the risk of this type of pollutant.¹⁸
- Promoting efficient recycling strategies and a circular economy that reduces plastic landfilling and incineration, encouraging the reuse of plastics, and reducing environmental contamination with Mps. In Romania, there is already a guarantee-return system for non-reusable primary packaging,³⁹ which has experienced significant growth in recycling plastic.
- Collaborating between local authorities, environmental organizations, and the private sector to implement innovative solutions for monitoring and preventing Mps pollution, including the development of new technologies for filtering and capturing them in wastewater and the natural environment. These recommendations from our study can guide decision-makers in addressing the problem of Mps at the national and global levels.

DISCUSSION

Reducing exposure to Mps requires both individual changes and collective action to reduce plastic pollution.⁴⁰ An essential first step is to avoid single-use plastic containers and utensils,^{41–43} opting instead for sustainable alternatives such as glass, stainless steel, or bamboo. Also, drinking filtered water instead of bottled water can significantly reduce the ingestion of plastic particles from packaging. Choosing clothes made from natural fibers, such as cotton or wool, instead of synthetic ones helps reduce plastic microfibers released during washing,⁴⁴ and using a special filter for your

washing machine can prevent them from entering wastewater. In the kitchen, avoiding heating food in plastic containers and reducing the use of plastic wrap are simple but effective measures to limit food contamination with microparticles. Collectively, promoting proper recycling,^{45,46} participating in greening campaigns, and supporting initiatives to reduce plastic use play a crucial role in combating this invisible form of pollution. By adopting these measures, exposure to Mps can be significantly reduced, thus protecting both human health and the environment.

CONCLUSION

This study explored the hidden sources of Mps in everyday life, their impact on both the environment and human health, and accessible solutions to reduce exposure. Despite being invisible, Mps are present in air, water, soil, and food, originating from sources such as synthetic textiles, plastic degradation, and industrial processes. Their widespread presence raises serious concerns about biodiversity loss, ecological imbalance, and potential health risks, including oxidative stress, immune system disturbances, and endocrine disruption.

To investigate this issue, a systematic documentary review was conducted, analyzing scientific literature, government reports, and case studies to identify hidden sources of Mps, assess their pathways into the human body, and evaluate strategies for reducing exposure. This approach provided a comprehensive understanding of Mps contamination and its far-reaching consequences. The findings reveal that Mps are increasingly accumulating in ecosystems, being ingested by aquatic and terrestrial organisms, and entering the food chain. While their full impact on human health remains under-researched, existing studies indicate potential risks that require urgent attention. Despite growing awareness, regulatory measures and mitigation strategies remain insufficient at both national and global levels.

To effectively combat Mps pollution, a collaborative effort is needed, involving policymakers, researchers, industries, and the public. Stricter regulations on plastic production, improved waste management, and the promotion of sustainable alternatives are essential. In Romania, where MP research is still in its infancy, authorities must intensify studies, implement stronger

environmental policies, and enhance public awareness campaigns. Legislative action, combined with responsible consumer behavior, is crucial in reducing Mps pollution and safeguarding both environmental and human health.

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