



Occupational Risks of Microplastics in Textile Manufacturing: Health Impacts and Mitigation Strategies

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Authors' contributions

This work was carried out in collaboration among all authors. Authors JCGDM and DKRDL contributed to the technical review. Authors AMDS, GBCJ and DGK contributed to the research and technical review. All authors read and approved the final manuscript.

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ABSTRACT

Background: In the textile sector, the atmospheric release of MPs during the manufacturing, drying and use of synthetic fabrics has also been observed, in addition to the sewing process, where small

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structural changes in the fabric network favor the release of polyester and polypropylene fibrils. In this context, the present study aimed to discuss, through a literature review, occupational exposure to MPs in the textile manufacturing sector.

Methodology: This study was characterized as a descriptive bibliographic review, focusing on the search for theoretical references in scientific journals, theses and dissertations.

Results and Conclusions: To reduce employee exposure, it is important to properly use personal protective equipment, including face masks, which reduce exposure to microfibers in the oral and nasal mucosa, reducing the possibility of ingestion and inhalation of these. Furthermore, an adequate ventilation and exhaust system makes it possible to remove suspended particles from the work atmosphere, and must be combined with filters to prevent release into the factory's external environment, as they mitigate the exposure of the upper respiratory tract and mouth to microplastics released into the environment.

Keywords: Microplastics; exhibition; textile sector.

1. INTRODUCTION

Plastics are organic polymeric products, and their main production source is fossil fuels, such as petroleum. Based on their chemical structure, they have different physical properties and commercial applications, the main ones being: polyethylene terephthalate, polystyrene, polyvinyl chloride, polypropylene, polyester and polyethylene (Caixeta; Morais, 2022; Li, et al., 2023).

The global production of plastic exceeds 400 million tons/year, while, in the national context, Brazil produces more than 6 million tons/year. Much of this material is not recovered or recycled, being disposed of incorrectly in the environment, resulting in degradation and the formation of small fragments or particles that can be called "microplastics - MP" (Caixeta; Morais, 2022; Li, et al., 2023). According to Wu et al (2017). These elements can be defined as different materials, varying in shape and size, density and chemical composition, and often consist of particles smaller than 5 mm in length.

The routes of exposure to microplastics involve contact with water, food, products, tissues and particles dispersed in the atmosphere, favoring the ingestion, dermal exposure and inhalation of particles of these materials (Prata et al., 2020; Haristama et al., 2023). MPs can trigger inflammatory processes in the skin, mucosa, lungs, respiratory, neuronal and gastrointestinal systems, due to cytotoxicity and physiological changes (Kumar et al., 2024).

Ingestion can occur from particles present in processed foods, bioaccumulated in natural products, occurrence in liquids or through contact of atmospheric particles with the oral mucosa.

They then reach the intestinal tract, where they can promote an inflammatory process in local cells or be absorbed and distributed to other organs, including the liver (Condor et al., 2019; Yang et al., 2023; Sun et al., 2023).

Dermal exposure occurs through skin contact with plastic products and synthetic fabrics (polypropylene and polyester), which can lead to dermatitis or topical absorption due to local exposure. Finally, respiratory exposure occurs through the inhalation of particles present in the atmosphere, as observed in plastic product recycling sites or the textile manufacturing sector (Condor et al., 2019; Yang et al., 2023; Sun et al., 2023).

In the textile sector, the atmospheric release of MPs during the manufacture, drying and use of synthetic fabrics has also been observed, in addition to the sewing process, where small structural changes in the fabric network favor the release of polyester and polypropylene fibrils (Kumar et al., 2024). According to Gallagher et al., (2015) exposure to synthetic microfibers favors processes of alteration of epithelial cells in the gastrointestinal tract, resulting in greater risks for stomach and esophageal cancer. Zarus et al., (2023) carried out a review and observed reports of inflammatory processes in the skin, reduced lung function and alveolar changes in textile sector workers exposed to synthetic fabric particles. Important occupational prevention measures are taken in this sector.

Adequate ventilation systems and the use of Personal Protective Equipment (PPE) are required to reduce occupational exposure to the aforementioned synthetic particles, and consequently reduce the possibility of inhalation and ingestion of these particles

(Shahsavari-pour et al., 2023; Igwe et al., 2023). In this context, the present study aimed to discuss, through a literature review, occupational exposure to MPs in the textile manufacturing sector.

2. METHODOLOGY

This study was characterized as a descriptive bibliographic review, focusing on the search for theoretical references in scientific journals, theses and dissertations. To this end, databases were consulted, with the descriptors: microplastics; occupational exposure; textile manufacturing and occupational health. Databases for research include Scielo, Springfield and Science Direct. Bibliographic sources in Portuguese, English and Spanish were selected, considering the corresponding time period between 2017 and 2024.

The first analysis of the text involved reading the title and abstract of 60 initial texts. After a detailed reading of the texts, 22 were selected for use in the review of the present study. The exclusion criteria involved there is no correlation between the study themes; duplicate texts and just as a simple abstract.

3. OCCUPATIONAL EXPOSURE TO MICROPLASTICS AND HEALTH RISKS

3.1 Occupational Exposure in Textile Manufacturing

In the textile manufacturing sector, especially in developing countries, professionals work in conditions of intense occupational risk, including exposure to noise and particulate matter (microfibers). Added to this is the lack of adequate air circulation in many manufacturing units, and problems with the use of PPE (Levillain et al., 2020; Rathinamoorthy; Balasaraswathi, 2023).

Continued exposure to microplastics from synthetic fabrics can generate acute and chronic occupational risks for workers in the textile sector. In the first case, inflammatory processes, especially at the dermal, pulmonary, intestinal and hepatic levels. In the second instance, prolonged physiological changes such as cardiac, hepatic and neurological dysfunction and cancer risks may occur (Condor et al., 2019; Agulló, Sanz et al., 2021). Other consequences for the health of employees will be detailed in the

following topic. In some studies, the occurrence of changes in epithelial cells in the gastrointestinal tract was cited, favoring the emergence of cancers, while in the respiratory system, changes were observed in the alveolar and respiratory capacity of professionals in the textile sector exposed to synthetic fibers (Gallagher et al., 2015; Zarus et al., 2023).

3.2 Health Risks

Occupational exposure to microplastics occurs mainly through inhalation, ingestion and topical contact with these elements, which can cause damage to local organs (lungs, intestines and skin) and be absorbed, thus reaching systemic organs, such as bones, nervous system and liver. The inhalation of microparticles, suspended in the atmosphere, enters through the upper areas (mouth or nose) and is inhaled, reaching the lungs. In this location, they can react with epithelial cells and stimulate acute or chronic inflammatory processes. Ingestion, in turn, occurs through contact of microplastics with the oral mucosa, present in the air, or carried by the hand, liquids or food contaminated with these materials, and thus are swallowed and reach the gastrointestinal tract. In this location, they can lead to cellular changes that trigger edema, pain or vomiting. Dermal exposure occurs through contact between unprotected skin and microparticles in the environment, and this exposure can lead to inflammatory processes in the skin, such as edema and itching (Condor et al., 2019; Yang et al., 2023; Sun et al., 2023). The effects on these involve physical and mechanical damage (causing abnormalities in internal organs or obstructions) and physiological changes (Prata et al., 2020; Lee et al., 2023) – Fig. 1.

As described in the image above, it can be seen that direct contact with the skin can cause dermal inflammation, which may include erythematous plaques, itching or burning. At the pulmonary level, MP can promote cellular changes and inflammation that affect hematosi, which can result in coughing and shortness of breath.

In the gastrointestinal tract, there are cellular changes, reduced absorption of nutrients, pain and a reduction in the microbiota, favoring the emergence of opportunistic infections (Condor et al., 2019; Pastor; Agulló, Sanz et al., 2021; Yang et al., 2023; Sun et al., 2023). In all these cases, there is the possibility of absorption of microplastics, thus spreading to other tissues

and organs, resulting in damage to the liver (hepatotoxicity), heart (cardiotoxicity and risk of heart attack), nervous system (neurotoxicity and reduced cognitive capacity), muscles (tissue atrophy) and bones (reduced osteogenesis and production of blood cells). This set of changes ends up interfering with the body's homeostasis, reducing, for example, immunity and physical and mental performance (Condor et al., 2019; Pastor; Agulló, Sanz et al., 2021; Yang et al., 2023; Sun et al., 2023).

To reduce employee exposure, it is important to use appropriate PPE, such as face masks, which are essential as they mitigate the exposure of the upper respiratory tract and mouth to microplastics released into the environment. Furthermore, adequate air circulation in the work environment is important, for example through extractor fans with filters, reducing the dispersion of local particles (Levillain et al., 2020; Rathinamoorthy; Balasaraswathi, 2023; Bollaín and Vicente, 2020; Olea, 2024).

Table 1. Summary of observations in the literature regarding studies on microplastics

Location	Observations	Sector	Bibliographic Source
Irã	They observed the occurrence of microplastics on the hands (25.72%); saliva (9.38%); face (28.42%) and hair (35.84%) among the participants.	Factory of polyethylene bags, tarpaulins and polypropylene fabrics.	Shahsavari-pour et al (2023)
Romania	They found microfibrils in the company's atmosphere (93%) smaller than 100 µ in length.	Study of fibrils in the atmosphere of a textile industry working with polyester.	Scarlat et al (2024)
China	They observed the release of microfibrils in abrasion tests on polyester fabric.	Abrasion study on polyester fabrics for microfibril release.	Yang et al (2023)
England	They mentioned the occurrence of polyester microfibrils in the sewing and washing process of fabrics.	The study analyzed the release of polyester microfibers during the washing, cutting and sewing processes of synthetic fabrics in the textile sector.	Allen et al (2024)

Source: Authors, 2024

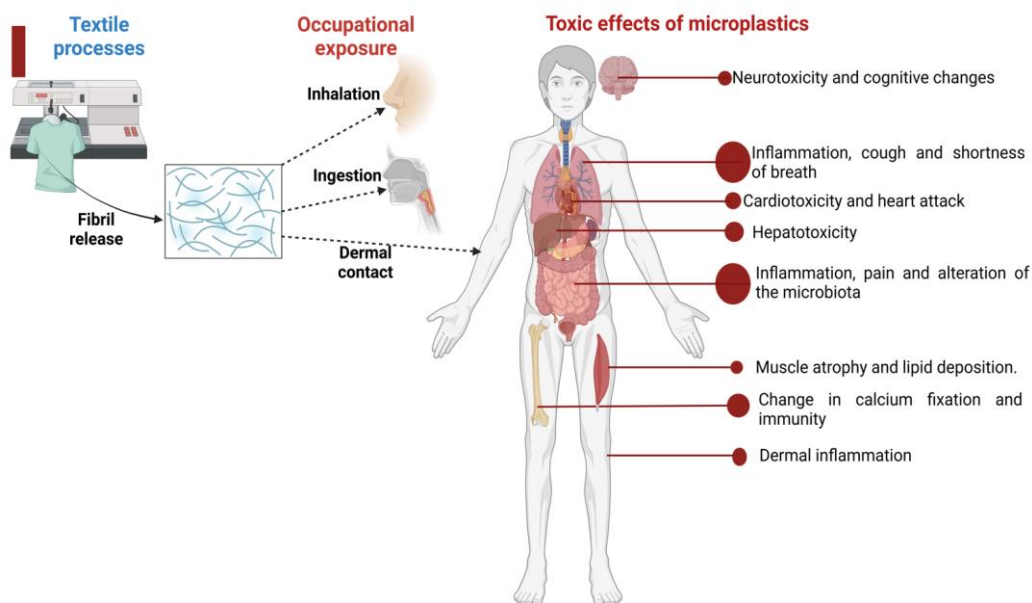


Fig. 1. Biological effects of exposure to microplastics.

Source: Created in <https://BioRender.com>; Authors, 2024

4. CONCLUSIONS

Occupational exposure to microplastics in the textile sector is a matter of concern, since many garment factories have failures in the use of PPE or inefficient exhaust systems. In this sense, there are important studies that favor the dissemination of knowledge on the subject.

This review allowed us to present the health risks to professionals exposed to polypropylene, polyester and polyethylene microfibrils, resulting in risks to the protective, neurological, digestive and dermal systems. In addition, prolonged exposure to the compounds present in these microplastics can favor the development of cancers in professionals in the sector. Field studies regarding occupational exposure in the text sector are necessary to understand the reality of exposure to microplastics.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript. All content of the manuscript was designed, written and corrected by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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