Potential Toxic Effects from Micro- and Nanoplastics: Insights from Occupational Studies

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Problem: Exposure & Effects are not Characterized

Microplastics are ubiquitous. Although studies report microplastics in our air, food, and water, more data is needed to evaluate their impact on human health. Size, shape, type, and properties to assess human health are lacking in many articles, and we know less about nano-plastics (explained in Zarus 2020). Animal studies indicate dose response, but they do not translate to human exposures (Porter et al. 1999). Therefore, the challenge remains to design studies to best measure human exposures and assess health effects.

Our Solution: Learn from Worker Exposure Studies

Studies of worker exposures in varying industries that produce plastic particles reported that workers can inhale nano-plastics or ingest microplastics. The industries include surface texture applications (flocking); synthetic textile manufacture, weaving, and cutting; and workplaces involved with producing, cutting, or applying polyvinyl chloride (PVC). The table below summarizes workplace exposures to micro and nano plastic by type and the measured health effects. Most studies find respiratory effects from all microplastic types, and some microplastics are associated with unique effects.

Worker Exposures to Microplastics and Nanoplastics

<table>
<thead>
<tr>
<th>Nanoparticle Type</th>
<th>Industry</th>
<th>Study Details</th>
<th>Replicates and Sample Size</th>
<th>Health Effects and Health Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester fibers</td>
<td>Textile</td>
<td>Workers were exposed during flocking; identified flocks of polyester fibers in sputum.</td>
<td>Not Stated</td>
<td>Increased pulmonary surfactant concentrations, respiratory symptoms, and subjective health complaints.</td>
<td>New Study</td>
</tr>
<tr>
<td>polyester nanotubes</td>
<td>Textile</td>
<td>Workers exposed to flocks of polyester fibers in sputum</td>
<td>Not Stated</td>
<td>Increased pulmonary surfactant concentrations, respiratory symptoms, and subjective health complaints.</td>
<td>New Study</td>
</tr>
<tr>
<td>TEMO Nanoplastics</td>
<td>Textile</td>
<td>Workers exposed to flocks of TEMO nanoplastics in sputum</td>
<td>Not Stated</td>
<td>Increased pulmonary surfactant concentrations, respiratory symptoms, and subjective health complaints.</td>
<td>New Study</td>
</tr>
<tr>
<td>textile nanotubes</td>
<td>Textile</td>
<td>Workers exposed to flocks of textile nanotubes in sputum</td>
<td>Not Stated</td>
<td>Increased pulmonary surfactant concentrations, respiratory symptoms, and subjective health complaints.</td>
<td>New Study</td>
</tr>
<tr>
<td>Nanotubes</td>
<td>Textile</td>
<td>Workers exposed to flocks of nanotubes in sputum</td>
<td>Not Stated</td>
<td>Increased pulmonary surfactant concentrations, respiratory symptoms, and subjective health complaints.</td>
<td>New Study</td>
</tr>
</tbody>
</table>

Findings: Summary of Health Effects

Numerous studies indicate respiratory effects from inhalation of plastic particles and fibers. However, there are some differing health effects associated plastic type and specific workplace duty within the facilities. The activities suggest that size, shape, type, and route of exposure play a role. Longer-term exposures and higher concentrations resulted in more severe health effects. Polystyrene, nylon, aramid, polypropylene, and PVC exposures showed differing effects.

All Plastic Exposures: Human studies showed respiratory effects, including restricted airways, pulmonary inflammation, reduced lung function, and abnormal lung X-rays. While measurements are lacking in most of these studies, effects have been reported with respirable particulate levels as low as 0.53 mg/m³ in the flock industry. Loss of lung function increased with years worked, with duster environments, and smaller particles. Findings from animal studies showed immediate inflammation and pointed to a dose response relationship (Porter et al. 1999). Reduced lung function was measured as reduction of forced expiratory volume (46–81%) and forced vital capacity (39–56%) in these studies (referenced on table).

Implications: Use Best Practices from these Studies for Workers and General Public

Although workers experience higher doses than the public, results from these occupational studies reveal endpoints and sampling methodology that should be targeted in environmental studies. Therefore, comprehensive human health risk studies will require that standardized measurement and sampling protocols (with greater volumes of air) are developed.

ATSDR & NCEH have proposed these (referenced) best practices along with added quality assurance to minimize sample contamination. These practices were shared with the Nanotechnology Environmental and Health Implications Working (NEHI) Group at Nano.gov to develop a multi-agency approach. Waterborne methods are available for review and air methods are still being developed at NEHI.

Draft method development site:

Thanks to Aashki Brockington initiating work into residential microplastic air sampling methods.

References available at:

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