CHEMWATCH

TECHNICAL

Week of 27 March 2026

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OCCUPATIONAL

From waste to workplace: Airborne microplastics and endotoxins in an indoor industrial environment

International journal of hygiene and environmental health 2026 Mar 21:274:114789 · 21 Mar 2026

Airborne microplastics (MPs) and endotoxins are emerging occupational hazards, yet their co-occurrence in real workplaces is poorly documented. The study examined combined exposure in sludge-based fertilizer plant, where digestate handling and drying generate both polymer-rich dust and bioaerosols. Personal and stationary air samples were collected with calibrated pumps at three indoor hotspots: conveyor pipe, dryer, loading dock with an outdoor site. Microplastics were extracted in an ultra-clean laboratory and characterized by μ-FTIR imaging. Endotoxin levels were quantified by the LAL assay. Indoor air contained significantly higher MP counts (24-312 MP m-3) than outdoor (13 MP m-3), dominated by fragment-shaped particles (74%) vs fibres (26%) within the inhalable size fractions. Concentrations peaked near the sludge dryer unit and the conveyor, indicating process-related sources and resuspension of contaminated dust. Endotoxins (<0,7 - 30 EU m-3) were consistently above outdoor levels and highest where sludge-derived material was agitated yet remained below occupational reference values (90 EU m-3). Positive covariation between MP and endotoxin levels suggested that tasks and zones with high dust emissions also drive combined particle-biological exposure. The study provides one of the first integrated datasets on airborne MPs and endotoxin in a circular-economy fertilizer facility and demonstrates a practical, contamination-controlled protocol for joint assessment using coordinated sampling. The results show that workers can be simultaneously exposed to elevated levels of polymer particles and endotoxin, underscoring the need to include microplastics in exposure monitoring, risk assessment, and control strategies across biological-waste and related industrial environments.

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Hippocampal subfields volumes as biomarkers for early diagnosis of asymptomatic manganese overexposure

NeuroImage 2026 Mar 20:331:121871 · 20 Mar 2026

Chronic occupational manganese (Mn) overexposure is associated with motor and cognitive deficits, but its effects on hippocampal subfields remain underexplored. Although neurodegeneration is known to involve the hippocampus, subfield-specific structural abnormalities have received limited attention. This study aimed to assess the diagnostic power of hippocampal subfield volumes in discriminating asymptomatic Mn-exposed welders from healthy controls (HCs). Mn-exposed welders and age-matched HCs were recruited and underwent high-resolution T1-weighted MRI

scans. Volumes across 19 hippocampal subfields of each subject were estimated from automated tissue segmentations and surface-based reconstruction using FreeSurfer. The laterality value was defined as: (Right-Left)/(Right+Left)*100. Between-group differences in subfield volumes and laterality were assessed using cross-sectional analysis. Three machine learning classifiers, including logistic regression, K-nearest neighbors and support vector machine (SVM), were applied to differentiate welders from HCs. Compared to HCs, Mn-exposed welders had reduced volumes mainly in the fimbria, subiculum, and presubiculum, while showing higher volumes in the cornu ammonis area 3 (CA3). The welders group demonstrated significant rightward laterality in CA1 and CA4, and leftward laterality in the presubiculum. Among the three classifiers, the SVM classifier achieved the best performance (AUC = 0.96) in distinguishing welders from HCs using subfield volumes. Additionally, the exposure duration was non-linearly associated with left fimbria volume. These results revealed distinct volumetric and asymmetric patterns in hippocampal subfields among Mn-exposed welders, indicating regional vulnerability and potential compensatory responses. Notably, our findings underscored that hippocampal subfield volumes might serve as imaging biomarkers for early diagnosis in individuals with asymptomatic Mn overexposure.

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CHEMICAL EFFECTS

Mixture risk assessment of nine reproductive toxic chemicals affecting male sperm quality in a representative sample of children and adolescents living in Germany - results from the German Environmental Survey (GerES V)

International journal of hygiene and environmental health 2026 Mar 20:274:114783 · 20 Mar 2026

Reproductive health is declining globally, with growing evidence linking exposure to endocrine-disrupting chemicals during critical pregnancy stages to adverse male sexual development. This study assessed the cumulative risk of nine such chemicals-acrylamide, PCB 118, DEHP, DnBP, DiBP, BBzP, DiNP, DCHP, and DnPeP-and possible influencing factors such as age, socioeconomic status (SES), and region (former East vs. West Germany). We analyzed cross-sectional data from the German Environmental Survey for Children and Adolescents 2014-2017 (GerES V), including 1090 participants with complete urine and plasma samples. Using the Hazard Index (HI) method, which combines exposure levels with human biomonitoring guidance values, we found that 31% of participants had an HI above 1, indicating elevated risk from combined chemical exposure. Notably, 26% of these cases would have gone unnoticed in single-substance assessments. DnBP, DiBP, and acrylamide were the main contributors to overall risk. Stratified analyses revealed that younger children had higher HI levels than older ones. Children from lower SES backgrounds also showed higher risk compared to those from medium or high SES groups. Additionally, residing in former East Germany was associated with increased HI levels compared to former West Germany. These findings emphasize the importance of considering chemical mixtures in risk assessments and recognizing subgroup-specific vulnerabilities. Future assessments should expand the range of included chemicals and focus on high-risk groups-especially children, individuals with low SES, and residents of former East Germany-to better capture the scope of potential health impacts.

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Serum polychlorinated biphenyls and risk of metabolic dysfunction-associated steatotic liver disease: Cross-sectional and prospective analyses from the Dongfeng-Tongji cohort

Environmental pollution (Barking, Essex : 1987) 2026 Mar 18 · 18 Mar 2026

Polychlorinated biphenyls (PCBs) are persistent endocrine-disrupting pollutants, yet evidence linking PCB exposure to metabolic dysfunction-associated steatotic liver disease (MASLD) remains limited, particularly across disease onset and fibrosis burden. We measured serum concentrations of seven PCB congeners (PCB-28, PCB-52, PCB-101, PCB-118, PCB-138, PCB-153, and PCB-180) in 2013 among 3,260 participants from the Dongfeng-Tongji cohort, a prospective study of retired employees in China, with follow-up examinations every five years. We examined associations of individual congeners and congener-group summary measures with prevalent and 5-year incident MASLD using multivariable logistic regression. Restricted cubic splines and mixture models characterized dose-response and mixture effects, with subgroup analyses by gender and lifestyle factors. We further assessed liver injury and fibrosis indicators using multivariable logistic and linear regression, including multinomial logistic models for Fibrosis-4-based risk categories. Overall, higher levels of PCB-28, PCB-118, PCB-153, lower- and higher-chlorinated PCBs, and ΣPCBs were associated with increased MASLD prevalence, with stronger associations among males, ever smokers, and frequent meat consumers. Mixture models assigned the greatest weights to PCB-28 and PCB-118. Prospectively, higher ΣPCBs predicted incident MASLD, mainly driven by PCB-118 (OR = 1.70, 95% CI: 1.10-2.64). PCBs were also associated with increased odds of liver injury and higher ALT, GGT, and ALP. Among participants with MASLD, higher PCBs were associated with higher dAAR and FIB-4, and greater odds of high fibrosis risk. These findings indicate that higher PCB exposure was linked to increased MASLD risk, liver injury, and fibrosis burden, suggesting PCBs are modifiable environmental risk factors for MASLD.

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ENVIRONMENTAL RESEARCH

Source apportionment and health risk assessment of heavy metal contamination in spring-groundwater continuum using multivariate analysis: evidence from the Bailadila iron ore mining region

Environmental geochemistry and health 2026 Mar 22;48(6) · 22 Mar 2026

Mining-induced heavy metal contamination poses a potential threat to the water security of Central India's tribal-dominated zones, despite the scarcity of integrated hydrogeochemical studies with multi-pathway health risk appraisals. To investigate the seasonal variations in spring water (n = 15) and groundwater (n = 47) quality within four river basins in the region of the Bailadila Iron Ore Mining area, Chhattisgarh using hydrogeochemical diagrams, multivariate statistical analysis, and comprehensive health risk modeling were adopted. The samples collected during two seasons, namely pre-monsoon and post-monsoon were analyzed for eleven heavy metals, major ions, and physico-chemical parameters utilizing the standard methods. The Gibbs plots suggested the weathering of rocks as the major geochemical process, while Piper diagrams showed predominantly Ca-Mg-HCO3 water types associated with carbonate dissociation. Principal Component Analysis and Hierarchical Cluster Analysis were used to distinguish three sources of contamination, i.e.,

geogenic weathering, mining operations, and agricultural activities. Strong correlations between mining-related metals (Cr-Pb: r = 0.71) and agricultural indicators (Na-K-Nitrate: r = 0.94-0.95) were observed based on Pearson correlation. The ANNOVA results revealed that the Sankani and Talperu basins had the highest levels of contamination, with considerable geographical differences (F = 39.14, p < 0.001). Health risk assessment revealed elevated non-carcinogenic hazards (89% samples THI > 1.0; range 0.73-3.93), with children most vulnerable (pre-monsoon avg. THI 1.85). Arsenic dominated carcinogenic risk (82-92% TCR contribution; max 0.13 mg/L pre-monsoon vs. WHO/BIS 0.01 mg/L), while iron (max 13.33 mg/L vs. WHO 0.3 mg/L, BIS 1.0 mg/L) and manganese (max 0.34 mg/L vs. WHO 0.4 mg/L, BIS 0.1 mg/L) drove 69% of non-carcinogenic risks. These findings underscore the importance of implementing long-term remediation strategies to safeguard vulnerable indigenous communities from mining-related health risks.

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Associations between pre-disease biomarkers of persistent organic pollutants and amyotrophic lateral sclerosis risk in four European cohorts

Environmental research 2026 Mar 19 · 19 Mar 2026

METHODS: We identified 166 incident ALS cases between 1993 and 1997 using the Danish National Patient Register and randomly selected 334 controls by individual matching on birth-year and sex. Levels of 13 polychlorinated biphenyls, 9 organochlorine pesticides and 3 polybrominated diphenyl ethers were assessed from baseline plasma samples. We employed conditional logistic regression models using exposure quartiles, and generalized additive models (GAMs), adjusting for confounders. We conducted a meta-analysis combining 3 Finnish prospective cohorts with the Danish data using a random-effects model.

RESULTS: The Danish results suggested generally inverse trends between several POPs and the predicted ALS risk; especially for chlordane-related compounds (co-pollutant quartile model, p-value<0.01). GAMs supported these trends, although most were not statistically significant. However, hexachlorobenzene was positively associated with ALS risk in co-pollutant GAM (p-value=0.02). Additionally, the GAMs suggested higher ALS odds at the highest levels of exposure of some POPs, but the data at these levels was sparse. Meta-analysis results were mostly consistent with the Danish findings.

CONCLUSION: Our study suggested elevated ALS risk among those exposed to hexachlorobenzene when adjusting for co-pollutants. Higher level of some POPs suggested a positive association with ALS occurrence, but the data was scarce at these levels.

OBJECTIVES: Previous retrospective studies suggested that occupational exposures to persistent organic pollutants (POPs) may be associated with amyotrophic lateral sclerosis (ALS), but prospective studies with biomarker exposure assessment are scarce. This study aimed to prospectively investigate the relationship between POP exposures and ALS risk in the Danish Diet, Cancer and Health study (EPIC) cohort and to conduct a meta-analysis including results from the prior study of 3 small prospective Finnish cohorts in addition to the Danish EPIC cohort.

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Sustainable NADES and Ultrasound-Assisted Extraction of PFAS and Microplastics in Environmental Matrices

Critical reviews in analytical chemistry 2026 Mar 22 · 22 Mar 2026

Emerging pollutants such as per- and polyfluoroalkyl substances (PFAS) and microplastics threaten the environment and human health due to their persistence, bioaccumulation, and ubiquity in aquatic systems, soils, and food chains. Recent research reveals synergistic effects, with microplastics serving as carriers that enhance PFAS adsorption, trophic transfer, and combined toxicity manifesting as oxidative stress, reproductive disruption, developmental abnormalities, and genotoxicity in organisms and human cells. These co-occurring "forever chemicals" and plastic particles amplify global risks, worsened by climate change and rising emissions. Traditional sample preparation techniques are solvent-heavy, energy-intensive, waste-generating, and prone to analyte loss, matrix effects, and low recoveries in complex matrices. This review assesses progress in green analytical chemistry (GAC), aligned with its 12 principles. Promising approaches include natural deep eutectic solvents (NADES) biodegradable, low-toxicity mixtures from natural compounds like sugars, amino acids, and organic acids with tunable polarity and ultrasound-assisted methods for fast, low-energy preconcentration. These deliver higher recoveries, lower detection limits, and better alignment with green metrics (e.g., AGREEprep) for PFAS and microplastics analysis. Challenges remain in standardization, scalability across polymers/sizes, and balancing sustainability with sensitivity. Future efforts should focus on hybrid techniques, automation, bio-based materials, and integration with high-resolution detection for sustainable, routine monitoring.

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PHARMACEUTICAL/TOXICOLOGY

Combined toxicity of triclocarban and bisphenol S in zebrafish: Multi-level synergistic effects and driving mechanisms

Journal of hazardous materials 2026 Mar 17:507:141798 · 17 Mar 2026

Advancements in toxicology have clarified toxic effects across biological levels; however, the mechanisms driving chemical-mixture toxicity remain unclear. In addition, the concentration addition (CA) model commonly used in mixture risk assessment may introduce predictive bias by neglecting chemical interactions, yet the implications of such bias remain poorly understood. Using zebrafish as a model organism, we systematically assessed triclocarban (TCC) and bisphenol S (BPS) mixtures. The results showed that mixtures prepared at concentrations predicted by the CA model caused synergistic toxicity across multiple biological levels. Transcriptomics showed TCC and BPS shared limited similarity, differing mainly in functional attributes rather than differentially expressed gene numbers. Mixture exposure amplified transcriptional responses and introduced new biological processes, revealing molecular mechanisms driving synergism. Notably, metabolism, MAPK, calcium, Apelin, and FoxO pathways were significantly enriched, collectively promoting oxidative stress and apoptosis. These processes further synergistically mediated multi-system toxicity through interconnected pathways, manifested as cardiovascular abnormalities (elevated heart rate, pericardial edema, caudal vein constriction), immune dysregulation (proliferation of innate immune cells with cytokine alterations), and neurotoxicity (impaired neuronal development, dopamine depletion, and elevated GABA). These synergistic effects further induced malformations in organs

such as the swim bladders and yolk sac, disrupted normal physiological activities, and ultimately impaired embryonic development, leading to increased mortality. By contrast, applying the combination index (CI) as a correction factor shifted the combined effects predominantly toward additivity or antagonism. Overall, this study provides mechanistic insights into TCC-BPS interactions. Predictions based on the addition model may overlook chemical interactions, causing toxicological biases, while CI provides a validated correction across biological levels, highlighting its utility in mixture risk assessment.

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Cyhalothrin induced neurotoxicity via disrupting NF-ÎºB and L-glutamate signaling and functions in zebrafish (Danio rerio)

Comparative biochemistry and physiology. Toxicology & pharmacology : CBP 2026 Mar 19:305:110512 · 18 Mar 2026

Cyhalothrin is a neurotoxicant that elicits neurotoxicity by targeting voltage-gated sodium channels of nontarget species, leading to damaging neurotoxic effects. However, little has been reported on cyhalothrin's neurotoxicity in zebrafish; hence, the present study utilized zebrafish embryos to larvae to investigate cyhalothrin's neurotoxicity and mechanisms, employing multi-biomarker analysis. Behavioral analysis showed cyhalothrin altered the spontaneous activities of the embryos by eliciting hyperactivity and causing hypoactivity in larval locomotor movement. Biochemical analysis revealed modifications in the content of GABA, TNF-α, IL-1β, ROS and GSH. Histological examinations of the larval head and trunk tissues saw severe nuclei karyolysis and pyknosis, and infiltration of inflammatory cells, signifying cellular damage. RNA-sequencing of larval mRNA showed that cyhalothrin exposure caused upregulation of 525 differentially expressed genes (DEGs) and downregulation of 516 DEGs. It also disrupted gene expression in nervous and developmental systems, indicated by GO/KEGG pathways. Mechanism findings revealed that it regulated the gene expression levels of NF-κB (tnfa, il1b, map3k14a, nfkbiaa, nfkbiab and tnfrsf1a) and L-Glutamate signaling pathway (slc6a19a.2, slc1a5, si:ch1073-155 h21.2 and gls2a) to impair the GABA secretion. The results of molecular docking indicate that TNFα and IL1β binds more tightly to cyhalothrin in the NF-κB pathway and generate inflammation. The results showed that cyhalothrin elicited neurotoxicity in the zebrafish embryo, and the possible mechanism is that it induced inflammation, which in turn disorder GABA secretion. It may be utilized for evaluating zebrafish health and neurological disease studies.

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Liver steatosis induced by per- and polyfluoroalkyl substances exerts a limited influence on heterocyclic aromatic amine-mediated DNA damage at population-relevant exposure levels

Environmental pollution (Barking, Essex : 1987) 2026 Mar 18 · 18 Mar 2026

The human population is chronically exposed to complex mixtures of environmental contaminants. However, classical toxicological risk assessment still relies mainly on individual compound testing, often at high concentrations and over short treatment durations that poorly reflect real-life exposure. In this study, we investigated per- and polyfluoroalkyl substances (PFAS) and heterocyclic aromatic amines (HAA) mixtures at concentrations aligned with human serum measurements using

mechanistic knowledge of each compound. To evaluate mixture effects, we employed Hepoid®, a 3D human liver model composed of polarized, proliferative, metabolically active, and highly differentiated HepaRG cells for long-term cultures. At human population internal exposure levels, PFAS and HAAs, alone or in combination, induced steatosis measured by automated lipid droplet quantification along with early transcriptional stress responses, without increased DNA damage under mixture conditions, as assessed by 3 complementary genotoxicity and mutagenesis assays (comet assay, γH2AX immunolabelling and micronucleus assay). Overall, this study highlights the importance of concentrations, treatment duration and human-relevant metabolic competence in determining toxic outcomes. By reproducing realistic exposure scenarios in an advanced human liver model sensitive to low-dose mixture effects, this work contributes to improving human relevance of chemical risk assessment.

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