CHEMWATCH

TECHNICAL

Week of 12 June 2026

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OCCUPATIONAL

Multi-matrix biomonitoring of human exposure to extreme levels of atmospheric mercury in urban artisanal gold mining areas: A Colombian case study

Environmental research 2026 Jun 05 · 5 Jun 2026

Artisanal and small-scale gold mining (ASGM) is the largest anthropogenic source of atmospheric mercury (Hg) globally, yet residential airborne Hg data and associated health impacts remain scarce in urban ASGM settings. The Atrato River basin combines intense ASGM activity with fish-dependent communities, making it a priority region for exposure assessment. We assessed (i) seasonal airborne elemental Hg (THg-Air) in urban Quibdo (QO) and rural Negua (NA); (ii) urinary total Hg (THg-U), hair total Hg (THg-Hair), and hair methylmercury (MeHg-Hair); and (iii) the relative contributions of inhalation and diet using correlation and multiple linear regression. Airborne Hg was monitored at 68 sites across dry and rainy seasons (n = 4,608 readings). Biomarkers were analyzed in 127 residents (QO: n = 77; NA: n = 50). Mean THg-Air in QO exceeded international guidelines at 64% of sites (8.40 and 7.85 µg/m3 in dry and rainy seasons), with gold-shop peaks >50 µg/m3, whereas NA levels were ▮100-fold lower. THg-U was significantly higher in QO (10.66 vs. 3.25 µg/L, p<0.05), and 40% exceeded biomonitoring thresholds. MeHg accounted for ▮80% of hair Hg, reflecting dietary fish exposure. THg-Air correlated strongly with THg-U (r = 0.73-0.88), while hair biomarkers correlated with fish intake (r ≈ 0.47). Sex was the dominant hair-biomarker predictor (β ≈ 0.38), and occupational effects on THg-U emerged only through interaction terms. QO ranks among the most airborne-mercury-contaminated urban environments globally. Dual exposure pathways-inhalation of elemental Hg and dietary MeHg-affect workers and the general population respectively. Multi-matrix biomonitoring is essential, and urgent regulatory action is needed to protect vulnerable communities.

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Microplastic inhalation in waste management workers: evidence from nasal lavage and sputum analysis in a municipal landfill setting

Waste management (New York, N.Y.) 2026 Jun 07:222:115646 · 7 Jun 2026

Although landfills are considered significant sources of microplastics, workers' inhalation exposure has not yet been measured. This study provides direct evidence of microplastic inhalation among landfill workers by examining pre- and post-shift changes in respiratory samples and across occupational groups. 23 personnel were divided into three groups: office (n = 7), field (n = 12), and recycling plant (n = 4). Nasal lavage and induced sputum samples were collected before/after the work shift. Microplastics were extracted after digestion and density separation, identified under a

stereomicroscope, and their polymer type was confirmed by Raman spectroscopy. Nonparametric tests were used to analyze intra- and inter-group differences. Microplastics were found in 100% of the samples, and their concentration increased significantly in both sample types after the shift. The mean particle count rose from 20.5 to 28.5 MPs/10 ml in nasal lavage and from 12.1 to 19.4 particles/10 ml in sputum ($p < 0.001$). Fibers were dominant (>70% pre-shift; >60% post-shift. Low-Density Polyethylene, polyamide, polypropylene and polyethylene Terephthalate constituted the main distribution of polymers. Regression models identified occupational exposure and smoking as the main determining factors for significantly increasing post-shift microplastic loads in both respiratory samples. The load of microplastics in nasal lavage and sputum was also highly correlated ($rs > 0.85$). Occupational activity in landfills significantly increases the burden of inhalable microplastics and shows a clear pattern of increasing exposure with increasing occupational exposure (recycling > field > office). Nasal lavage is a valid, less invasive indicator for occupational monitoring and extensive epidemiological assessments.

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CHEMICAL EFFECTS

The comet assay as a tool for human biomonitoring of exposure to environmental and occupational agents - a summary of systematic reviews and meta-analyses

Mutation research. Reviews in mutation research 2026 Jun 05 · 5 Jun 2026

This paper compiles results from six systematic reviews and meta-analyses on associations between environmental and occupational exposure to chemicals and levels of DNA strand breaks in human leukocytes, measured by the comet assay. There are no differences in effect sizes when using different comet descriptors. However, lower central tendencies are obtained by using a non-parametric test as compared to the standard parametric analysis, indicating that the standard meta-analyses tend to overestimate the effect size. The compiled results indicate that exposures can be sorted into three groups with decreasing effect size: high (pesticides), moderate (volatile organic compounds, heavy metals and antineoplastic drugs), and low (anaesthetic gases and air pollution). Interestingly, studies from middle-income countries have higher effect sizes than those seen in studies from high-income countries. This may be related to higher exposures or lower socioeconomic status in middle-income countries. However, there is also some co-variability between studies from middle-income countries and the risk of comet assay measurement bias, assessed as information provided in published papers. Lack of information on assay controls and blinded/coded sample analysis appears to be a general issue in studies on comet assay results. Risk of exposure misclassification is mainly related to the type of exposure; there are good biomarkers for some exposures (e.g. heavy metals), whereas other exposures are more challenging to assess with biomarkers (e.g. pesticides). In conclusion, all examined exposures result in significant increases in DNA strand breaks at the population level, though to varying degrees.

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In vitro assessment of human dermal exposure to emerging bisphenols: Bisphenol E (BPE) and Bisphenol B (BPB)

Regulatory toxicology and pharmacology : RTP 2026 Jun 05:171:106158 · 5 Jun 2026

Bisphenol E (BPE) and bisphenol B (BPB) are emerging as alternatives to bisphenol A (BPA), although information on their toxicity and human exposure remains limited. While not formally classified as such, both compounds are suspected endocrine disruptors. To better evaluate potential occupational exposure, this study investigated their dermal absorption, following OECD guidelines for in vitro experiments. Experiments were conducted using freshly-excised human skin mounted on Franz diffusion cells. Skin samples were exposed for 20 h to radiolabelled BPE or BPB. Time-course analyses were used to determine key toxicokinetic parameters, including steady-state flux, lag time, and skin permeability coefficient (Kp). After exposure, compound distribution and potential skin reservoir effects were assessed by sequential tape-stripping and separation of epidermis and dermis. Permeability coefficients were determined: 4.2 × 10-3 cm/h for BPE; 3.4 × 10-3 cm/h for BPB. Approximately 49% of the applied dose of BPE and 36% of the applied dose of BPB were absorbed, whereas 20% and 29%, respectively, were retained in the skin. Overall, the results demonstrate substantial dermal absorption of BPE and BPB and highlight skin retention as a factor contributing to potential prolonged systemic exposure. These data provide important information for regulatory risk assessment.

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A human biomonitoring study evaluating exposure to imidacloprid among pet owners following the use of ectoparasite treatments

Environment international 2026 Jun 01:213:110346 · 1 Jun 2026

Imidacloprid (IMI), a neonicotinoid insecticide (NNI), is commonly used in ectoparasite treatments for pets. With the rise of pet ownership globally, there is also a rise in ectoparasite treatment use and a potential for human exposures to these chemicals. This study explored human exposures to IMI following IMI-based ectoparasite treatment application to household pets, using human biomonitoring methods. In this study, 67 participants in Irish households that applied IMI-based ectoparasite treatments provided five first-morning void urine samples for five days in a row. The first morning urine sample was collected the morning before treatment application, and then one sample was collected each of the following four days. All samples (n = 335) were analysed for IMI, and its metabolites, IMI-olefin and 4/5-hydroxy-IMI (OH-IMI). The study results show a pronounced increase in pet owners' urinary concentrations of IMI, IMI-olefin and OH-IMI in the days following the application. The detection frequency for IMI-olefin increased from 26% in pre-treatment samples to over 74% in post-treatment samples. Participants who had more physical interactions with the treated pet had markedly higher urinary concentrations of the IMI-olefin, as did participants who had used a larger quantity of IMI. However, all urinary concentrations indicated IMI exposures were below the Acceptable Daily Intake (ADI). Urinary concentrations persisted over the sampling period, with no notable decrease in concentrations of IMI-olefin or OH-IMI after five days of sampling. Future studies should aim to conduct sampling over a longer timeframe to find the duration of exposure from IMI product use.

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ENVIRONMENTAL RESEARCH

Particulate matter-bound metals and chlorinated paraffins co-exposure: A population-based study on attention-deficit/hyperactivity disorder in Chinese youth

Journal of hazardous materials 2026 May 22:514:142463 · 22 May 2026

Recent studies have indicated that heavy metals and chlorinated paraffins (CPs) are risk factors for neurodevelopmental disorders. However, evidence regarding their potential combined effects remains limited. To investigate the joint associations of heavy metals and CPs with attention-deficit/hyperactivity disorder (ADHD) symptoms, we recruited 122,965 participants under 18 from the Pearl River Delta in China. We measured concentrations of six heavy metals (Pb, As, Cd, Hg, Mn and Ni) and three types of CPs (SCCPs, MCCPs and LCCPs) in atmospheric particulate matter (PM2.5) samples. ADHD symptoms was defined according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition criteria. Generalized linear mixed-effects models (GLMMs) were used to evaluate the associations between individual pollutants and ADHD symptoms. We investigated the combined effects using a weighted quantile sum (WQS) regression model and examined potential interactions through both multiplicative and additive models. In single-pollutant models, all metals and CPs demonstrated significant positive associations with ADHD symptoms. Additive interaction analyses revealed significant synergistic effects between heavy metals and CPs, particularly between SCCPs and Mn (RERI = 4.63, 95% CI: 4.38, 4.88) and between SCCPs and Pb (RERI = 4.15, 95% CI: 3.92, 4.39). WQS analysis demonstrated a positive association between mixed exposure and ADHD symptoms, with Mn, Pb, and SCCPs as the main contributors. Boys and children younger than 12 years were more susceptible to these combined effects. These findings suggest that heavy metals and CPs may exert synergistic effects on the odds of ADHD symptoms, highlighting the importance of coordinated regulatory strategies targeting both pollutants.

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Prenatal cadmium exposure and behavioural and emotional problems across childhood: findings from the INMA birth cohort

Environmental research 2026 Jun 04;305(Pt 1):124941 · 4 Jun 2026

Prenatal cadmium (Cd) exposure may impair placental function and disrupt biological processes relevant to foetal neurodevelopment, including oxidative stress and metal homeostasis, but epidemiological evidence linking Cd to childhood behavioural and emotional problems remains inconsistent. We examined whether prenatal Cd exposure was associated with behavioural and emotional symptoms from early childhood to pre-adolescence in the Spanish INMA birth cohort. We included 1270 mother-child pairs from Valencia, Sabadell, and Gipuzkoa. Cd and creatinine were measured in maternal urine collected in the first and third trimesters of pregnancy, and average prenatal Cd exposure was analysed. Behavioural and emotional outcomes were assessed at ages 4-5, 7-8, 9, and 11 years using the ADHD-DSM-IV, Strengths and Difficulties Questionnaire, and Conners' Parent Rating Scales-Revised. Associations were estimated using multivariable negative binomial and mixed-effects models, with additional analyses for trimester-specific exposure, non-linearity, and effect modification by selected single nucleotide polymorphisms. Prenatal Cd exposure was not associated with any behavioural or emotional outcome across childhood. Results were also null when exposure was analysed separately for the first and third trimesters. In contrast, male sex

and maternal smoking during pregnancy were consistently associated with poorer behavioural scores, whereas higher parental education and parity were generally associated with lower symptom levels. Interaction analyses indicated greater susceptibility among children whose mothers carried the MT1DP rs8044719 GT + TT genotype. In this population-based cohort, prenatal Cd exposure was not associated with behavioural or emotional problems across childhood. The findings nevertheless suggest that genetic susceptibility may contribute to interindividual differences in Cd-related neurodevelopmental vulnerability.

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Environmental exposure to bracken-derived carcinogenic compounds: a multidisciplinary assessment in northern Spain

Environmental research 2026 Jun 05;305(Pt 1):124917 · 5 Jun 2026

Bracken (Pteridium aquilinum) is a globally distributed fern that produces carcinogenic illudane glycosides (IGs), raising concerns about environmental exposure in livestock-dominated ecosystems. However, the occurrence, mobility, and biological effects of these compounds in natural water systems remain insufficiently characterized. Here, we present a multidisciplinary assessment of IG distribution and genotoxic activity in northern Spain, integrating chemical analyses of plant tissues and environmental waters with in vivo and in vitro bioassays. Croziers and water samples from bracken-infested areas were analyzed for ptaquiloside (PTA), ptesculentoside (PTE), and thepterosins A and B. IGs and/or their derivatives were detected in all plant samples and widely in water sources, demonstrating environmental dissemination and persistence. Notably, elevated PTA levels were observed in croziers from sites associated with cattle mortality. Genotoxicity was assessed using the SMART assay in Drosophila melanogaster (in vivo) and comet assays in human cell lines (in vitro), revealing induction of somatic mutations and DNA damage by plant extracts and, to a lesser extent, by concentrated water samples. While genotoxicity in plants correlated with pterosin levels, weaker associations were observed in water samples. These findings identify a relevant pathway of environmental exposure linking bracken, water contamination, and biological effects. The widespread occurrence and bioactivity of IGs highlight potential risks for ecosystems and livestock, underscoring the need for environmental monitoring in bracken-dominated landscapes.

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PHARMACEUTICAL/TOXICOLOGY

Interaction between organophosphorus nerve agents and algae/cyanobacteria: a review of algal ecotoxicology, biotransformation and application

Journal of environmental management 2026 Jun 06:410:130152 · 6 Jun 2026

Organophosphorus nerve agents (OPNAs), represented by neurotoxic organophosphorus pesticides and chemical warfare agents, present formidable challenges to aquatic ecological security. As foundational primary producers, algae exhibit complex, bidirectional interactions with these contaminants. This review systematically synthesizes current knowledge on the fate of OPNAs in aquatic systems and their multifaceted interplay with algae. We elaborate on the toxicological mechanisms affecting algal physiology, the enzymatic degradation networks facilitating

bioremediation, and the genetic basis of adaptive evolution under chronic stress. Beyond environmental risks, we highlight the translational potential of these interactions, ranging from algal-based biosensors for rapid detection to engineered bioremediation systems for chemical threat neutralization. Furthermore, the necessity of establishing standardized ecotoxicity frameworks for persistent agents like VX is emphasized to support the safe demilitarization of chemical weapons. Finally, a future roadmap is proposed to bridge the gap between molecular insights and engineering applications, advocating for a paradigm shift from passive monitoring to active, nature-based solutions against global chemical pollution.

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Impact of chronic single or combined exposure to bisphenol A and perfluorooctanoic acid on human osteoblast spheroid

Environmental pollution (Barking, Essex : 1987) 2026 Jun 04 · 4 Jun 2026

Environmental exposure to endocrine-disrupting chemicals (EDCs) has increased substantially due to widespread industrial activities. Even at low doses, EDCs can interfere with hormonal signaling and affect multiple physiological systems, including bone. Among the most prevalent EDCs are bisphenol A (BPA) and perfluorooctanoic acid (PFOA). Although their individual effects are well documented in vivo and in in vitro 2D models, while the use of 3D bone models and their combined impact on bone tissue remains poorly explored. This study investigated the effects of BPA (50 µM) and PFOA (1 µM), alone or their co-exposure, using human fetal osteoblast (hFOB 1.19) spheroids cultured under osteogenic conditions for 21 days (chronic exposure). These concentrations were selected based on previous in vitro studies and preliminary evidence indicating adverse, yet non-cytotoxic effects, suitable for long-term experiments. Spheroid morphometry, cell viability, extracellular matrix (ECM) deposition, and related protein markers were evaluated. Cell viability was not significantly affected by EDCs exposure. However, morphometric analysis revealed dynamic structural changes throughout the exposure period. At early stages, the combined exposure exerted antagonistic effects on spheroid area, solidity, and roundness. By the end of the 21-day exposure, no evidence of synergistic or antagonistic effects was detected, with co-exposure responses largely reflecting the effects of the individual compounds. BPA and the combined exposure to both EDCs increased COL1A2 protein levels, suggesting a stiffer ECM, despite a concomitant reduction in ECM mineralization. Decreased mineralization was also observed following PFOA exposure. Overall, BPA and PFOA induce toxicity on human osteoblast spheroids highlighting the importance of human 3D models for evaluating chronic and combined EDCs exposure effects on human bone health.

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