

CHEMWATCH

# TECHNICAL

Week of 29 May 2026

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TECHNICAL

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# TECHNICAL

## OCCUPATIONAL

### Occupational pesticide exposure and association of monoclonal gammopathy of undetermined significance in the Western Macroregion of Paraná

Cancer epidemiology 2026 May 22:103:103119 · 22 May 2026

**BACKGROUND:** Monoclonal gammopathy of undetermined significance (MGUS) is a premalignant condition that precedes multiple myeloma and is associated with environmental factors, including pesticide exposure.

**MATERIALS AND METHODS:** This analytical observational study with a cross-sectional design assessed the prevalence of MGUS and its association with occupational pesticide exposure among men aged 50 years or older in the Western Macroregion of Paraná, Brazil. A total of 486 participants were allocated to the exposed group (n = 243) and the unexposed group (n = 243), according to self-report occupational pesticide exposure. All participants completed a standardized sociodemographic and occupational questionnaire and underwent laboratory tests. Comparisons between groups were performed using Pearson's chi-square or Fisher's exact tests. Crude and age-adjusted Poisson regression models were used to estimate prevalence ratios, and logistic regression models were used to investigate factors associated with MGUS.

**RESULTS:** The overall prevalence of MGUS was 4.74% (95% CI: 2.99-7.09) and was higher in the reference group classified as non-occupationally exposed (6.58%) than in the occupationally exposed group (2.47%). Age was associated with higher odds of MGUS (OR = 1.07; p = 0.009), and former smoking was associated with higher odds of MGUS (OR = 2.79; p = 0.038). No significant association was observed between occupational pesticide exposure and MGUS after adjustment.

**CONCLUSION:** No significant association was found between occupational pesticide exposure and MGUS. Age and former smoking were associated with MGUS in the study population. These findings should be interpreted with caution due to the cross-sectional design and limited number of MGUS cases, but contribute to the existing evidence on MGUS prevalence in populations with occupational pesticide exposure and highlight the need for further longitudinal studies.

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### Heavy metals, carbon monoxide and PBDE exposure among firefighters: a cross-sectional study

Scientific reports 2026 May 24 · 24 May 2026

Firefighters are subject to significant risks to their health, including an increased risk for significant morbidities due to exposure to pollutants. The aim of this study was to examine the magnitude of

firefighters' exposure to various hazardous substances in a large cross-sectional study. Detailed activity records of 108 firefighters, questionnaires blood and urine samples were collected and compared with 104 men with other occupations. Heavy metals, carboxyhemoglobin and PBDE levels were compared between firefighters and controls. Correlations were explored between pollutant levels and individual exposure frequencies to the total number of fire events, and by subtypes. Significant differences between firefighters and controls were observed in levels of Cr ( $0.41 \pm 0.52$  vs.  $0.2 \pm 0.14$   $\mu\text{g/g}$  creatinine,  $p$ -value = 0.006), Ni ( $0.55 \pm 0.63$  vs.  $1.13 \pm 0.59$ ,  $p$ -value < 0.001) and Pb ( $0.26 \pm 0.23$  vs.  $0.36 \pm 0.21$ ,  $p$ -value < 0.001). No significant difference was found in other metals, As ( $12.7 \pm 10.7$  vs.  $11.8 \pm 10.8$ ), Cd ( $0.26 \pm 0.14$  vs.  $0.23 \pm 0.10$ ), Hg ( $0.42 \pm 0.43$  vs.  $0.59 \pm 0.81$ ), as well in COHb levels ( $2.80\% \pm 1.66$  vs.  $3.01\% \pm 1.58$ ). Smokers exhibited significantly higher COHb levels. When adjusted for age and education, firefighters had significantly higher levels of As ( $p$  < 0.001) and lower levels of Ni ( $p$  < 0.001) vs. controls. We found low PBDEs levels, suggesting low exposure compared to firefighters from other countries. Exposure to fire events was not correlated with pollutant levels among firefighters. Israeli firefighters show low exposure to carbon monoxide, heavy metals, and PBDEs compared to international cohorts, though PBDEs levels exceed controls. No correlation exists between firefighting activities and pollutant levels, suggesting effective protective equipment use.

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## CHEMICAL EFFECTS

### Chemical mixtures and birth weight: comparison of multipollutant models in the Maternal-Infant Research on Environmental Chemicals (MIREC) study

Environmental health : a global access science source 2026 May 22 · 22 May 2026

Fetal growth is a critical health outcome influenced by prenatal exposure to environmental chemicals, particularly endocrine-disrupting chemicals (EDCs). Studies have shown that pregnant women are simultaneously exposed to multiple chemicals, illustrating the need for methods that can examine the health effects of cumulative exposures. We compared four statistical methods-Principal Component Analysis (PCA), k-means clustering, Weighted Quantile Sum Regression (WQSR), and Bayesian Kernel Machine Regression (BKMR), -to identify associations between the mixture of chemicals and birth weight z-scores, including phthalate metabolites, bisphenol A, bisphenol A alternatives, triclosan, organophosphate pesticides, arsenic species, glyphosate and its breakdown product aminomethylphosphonic acid (AMPA), solvent metabolites, organophosphate flame retardants, fluoride, polybrominated diphenyl ethers, polychlorinated biphenyls (PCBs), organochlorine pesticides (OCs), cotinine, per- and polyfluoroalkyl substances (PFAS), and five metals. Our complete case analysis investigated the potential effects of a mixture of 46 chemicals on birth weight z-score, using 1127 mother-infant pairs from the Maternal-Infant Research on Environmental Chemicals (MIREC) study. PCA showed a significant inverse association between birth weight z-score and a component with loadings highest for PCBs ( $-0.035$ , 95%CI: ( $-0.068$ ,  $-0.002$ )) using multivariable linear regression. The k-means analysis revealed distinct clusters of chemical profiles associated with lower birth weight z-score ( $-0.17$ , 95% CI: ( $-0.34$ ,  $-0.01$ )) using multivariable linear regression, and primarily composed of arsenic (As), mercury (Hg), lead(Pb),  $\Sigma$ OC Chlordane and the PCBs, WQSR showed an inverse association with the overall mixture index ( $-0.065$ ; CI: ( $-0.171$ ,  $0.04$ )) driven mostly by Aroclor 1260,  $\Sigma$ OC Chlordane, glyphosate, and PCB180. BKMR highlighted that the birth weight z-score was  $0.054$  ( $-0.100$ ,  $0.209$ ) when all chemicals in the

25th percentile were compared to their medians, which decreased to -0.04 (-0.219, 0.14) when all chemicals in the 75th percentile were compared to their median values. After stratification by infant sex, associations tended to be larger in magnitude in females. We observed, according to all four approaches, that  $\Sigma$ OC Chlordane,  $\Sigma$ OC Insecticides, Aroclor 1260, dimethylarsinic acid, Pb, PCB170 and PCB180 were most often associated with decreased birth weight. These findings underscore the potential adverse effects of chemical mixtures on birth weight, the usefulness of using multiple methods, and suggest the need for continued research for evaluating cumulative environmental exposures in prenatal health outcomes.

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## Sociodemographic and residential characteristics associated to persistent and non-persistent organic pollutants in household dust from Southern Spain. COVID-AND Study

Environmental research 2026 May 21 · 21 May 2026

**BACKGROUND:** Scientific evidence suggests that indoor dust contains chemical pollutants, such as per- and polyfluoroalkyl substances (PFAS), bisphenols, parabens, and benzophenones, which are present in building materials and everyday products and could have implications for human health.

**METHODS:** Household dust samples (n=102) were collected (2023- 2025) within the COVID-AND study (a multi-purpose cohort whose overall aim is to investigate factors associated with Sars-CoV-2 infection in Andalusia), across four cohorts, CAPLIFE, GENEIDA, MCC-Granada, and MCC-Huelva. Target liquid chromatography-tandem mass spectrometry was used to analyze ten PFAS, two bisphenols, four parabens, and five benzophenones. Associations with log-transformed chemical levels were analyzed using robust MM-estimator regression models adjusted for sociodemographic and residential variables.

**RESULTS:** Fifteen out of the 21 target chemicals were detected in all dust samples. Median concentrations ranged from 6.95 ng/g for PFHxA to 8590 ng/g for bisphenol A. High household income was positively associated with PFHxA ( $\beta$ :0.28, 95%CI 0.08,0.49), while University education was associated positively with benzophenone-3 ( $\beta$ :0.43, 95%CI 0.23,0.63). Manual work was linked to butylparaben ( $\beta$ :0.17, 95%CI 0.003,0.34). Densely populated areas were negatively associated with PFOA ( $\beta$ :-0.32, 95%CI -0.50, -0.13) and with older buildings PFOA ( $\beta$ :-0.007, 95%CI -0.01, -0.002). Higher cleaning frequency was linked to benzophenone-1 ( $\beta$ :0.17, 95%CI 0.02,0.32).

**CONCLUSION:** Sociodemographic and residential characteristics were associated with pollutant levels in household dust. Confirming these findings in future studies will help identify population groups at high risk of exposure.

**OBJECTIVE:** To quantify levels of PFAS, bisphenols, parabens, and benzophenones in household dust of four cohorts from Andalusia (Spain) and determine their relationship with sociodemographic and residential characteristics.

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## Ambient acetaldehyde exposure and daily mortality: first time-series evidence linking a group 1 carcinogenic VOC to deaths in Tianjin, China

Environmental geochemistry and health 2026 May 23;48(8) · 23 May 2026

Despite acetaldehyde's classification as a Group 1 carcinogen, population-level epidemiological evidence linking ambient acetaldehyde to mortality remains absent, impeding risk assessment and regulatory development. Here we present the first comprehensive two-stage time-series analysis examining associations between ambient acetaldehyde and daily mortality using 206,606 deaths across districts of Tianjin, China, during 2013-2019. After adjusting for meteorological variables, fine particulate matter (PM<sub>2.5</sub>), ozone (O<sub>3</sub>), long-term trends, and day-of-week effects, each 1 ppb increase in acetaldehyde was associated with significant mortality elevations at lag day 1: all-cause mortality increased by 3.45% (relative risk (RR) = 1.034, 95% confidence interval (CI): 1.019-1.050), non-accidental mortality by 4.26% (RR = 1.043, 95% CI: 1.027-1.059), and cardiovascular mortality by 3.36% (RR = 1.034, 95% CI: 1.016-1.052). Subgroup analyses revealed particularly elevated risks for ischemic heart disease (RR = 1.163, 95% CI: 1.134-1.193) and cerebrovascular disease (RR = 1.071, 95% CI: 1.045-1.097). Older adults ( $\geq 65$  years) exhibited higher susceptibility than younger individuals ( $P = 0.048$ ). Exposure-response analyses identified threshold effects at approximately 1.2 ppb for all-cause and non-accidental mortality, while cardiovascular and respiratory mortality demonstrated near-linear relationships without clear thresholds. These findings provide foundational evidence quantifying ambient acetaldehyde-associated mortality burdens and exposure-response relationships, supporting incorporation of acetaldehyde into air quality monitoring frameworks and development of evidence-based exposure standards.

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## Comprehensive evaluation of surface water quality: heavy metals, speciation, and human health risks in an industrial region of West Bengal, India

Environmental monitoring and assessment 2026 May 23;198(6) · 23 May 2026

This study evaluates the hydrogeochemical characteristics, heavy metal (HM) contamination, irrigation suitability, and associated human health risks of surface water in an industrial area affected by dye-manufacturing activities in West Bengal, India. A total of 30 surface water collected in triplicate were analysed. Major ions were determined using standard American Public Health Association (APHA) methods, HMs were quantified using atomic absorption spectrometry (AAS), and aqueous speciation was modelled using Visual MINTEQ. The water was slightly alkaline, with pH values ranging from 7.18 to 8.92 (mean  $7.79 \pm 0.41$ ). Extremely high salinity was observed, as electrical conductivity ranged from 2500 to 21,000  $\mu\text{S cm}^{-1}$  (mean  $11,300 \pm 4272 \mu\text{S/cm}$ ), while total dissolved solids varied between 1500 and 12,600 mg/L (mean  $6780 \pm 2563 \text{ mg/L}$ ), exceeding World Health Organization (WHO) guideline values. Major cations followed the order  $\text{Ca}^{2+} > \text{Mg}^{2+} > \text{Na}^+ > \text{K}^+$ , whereas dominant anions were  $\text{HCO}_3^- > \text{Cl}^- > \text{SO}_4^{2-}$ , reflecting combined geogenic and anthropogenic influences. Mean concentrations of heavy metals were elevated, with values of Cr (0.97 mg/L), Pb (0.23 mg/L), Ni (0.19 mg/L), Cu (0.06 mg/L), and Cd (0.004 mg/L). Except for Cu, all metals exceeded WHO permissible limits, indicating substantial contamination. Pollution indices (Pi) confirmed severe degradation, with  $\text{Pi} > 1$  for Pb, Ni, Cr, and Cd. High average values of Cd (48.89), Heavy Metal Evaluation Index (HEI), 53.65, and Heavy Metal Pollution Index (HPI), 338.73, indicated

high to extreme pollution, while Water Pollution Index (WPI) values (1.51-5.27) classified all samples as severely polluted. Speciation modelling showed Cd predominantly occurred as Cd<sup>2+</sup> (52.35%) and CdCl<sup>+</sup> (32.10%), suggesting high mobility. Lead (Pb) was predominantly present as PbCO<sub>3</sub>(aq) (39.47%) and PbHCO<sub>3</sub><sup>+</sup> (31.31%), Ni largely as Ni<sup>2+</sup> (63.15%), and Cr(VI) mainly as CrO<sub>4</sub><sup>2-</sup>. Copper was largely present as CuCO<sub>3</sub>(aq) (67.94%). Irrigation indices indicated suitability, although overall water quality remained poor. Human health risk assessment identified Pb and Cr as posing non-carcinogenic risks, while Cr presenting the highest carcinogenic risk, particularly for children (CR > 1 × 10<sup>-4</sup>). Overall, the findings highlight severe surface water degradation and underscore the urgent need for remediation measures and stricter regulatory intervention.

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## Solar-driven peroxyacid group activation enables 500 h stable hydroxyl-radical defluorination of industrial perfluorophenol wastewater

Nature communications 2026 May 24 · 24 May 2026

Fluoroarenes persist in aquatic environments because aromatic delocalization and aqueous speciation suppress selective C-F bond cleavage, limiting both reductive activation and direct hole oxidation. Hydroxyl radicals (·OH) can mineralize these contaminants, yet near-neutral·OH generation typically relies on added oxidants or Fenton chemistry, creating chemical demand and secondary residues. Here we report a carboxyl-functionalized crystalline perylene diimide photocatalyst (Carboxyl-PDI) that produces ·OH via a catalytic carboxyl-peroxyacid cycle under visible light. Carboxyl-PDI delivers a 50.94% apparent quantum yield for ·OH at 600 nm, achieves complete defluorination of 100 mg L<sup>-1</sup> perfluorophenol under AM1.5 G irradiation, and retains stable capacity for >500 h. Isotope labelling mass spectrometry and theoretical calculation identify a -COOOH intermediate and show hydrogen-bond gating to a neighbouring PDI carbonyl weakens the O-O bond by ~0.31 eV, enabling low-barrier homolysis for producing ·OH. A continuous-flow outdoor-sunlight reactor reaches 95.85% degradation, 90.67% defluorination and 79.68% mineralization, demonstrating scalable oxidant-free defluorination of perfluorophenol.

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### PHARMACEUTICAL/TOXICOLOGY

## Histopathology and Transcriptomics in Male Zebrafish Livers from a PFOS Multi-Generational Exposure Informs Adverse Outcome Pathway Development for Liver Steatosis

Environmental toxicology and chemistry 2026 May 24 · 24 May 2026

Poly- and perfluoroalkyl substances (PFAS) use in commercial products and industrial applications has resulted in widespread and persistent environmental contamination. Terrestrial and aquatic vertebrates accumulate PFAS in liver tissue potentially inducing hepatotoxicity. The present study investigated tissue-level and molecular effects in livers of male zebrafish (*Danio rerio*) exposed for two generations to perfluorooctanesulfonic acid (PFOS). Histopathology and transcriptomic expression analysis (RNA sequencing) were performed for males exposed to PFOS (0 [control], 0.1, 0.6, 3.2, 20, and 100 µg/L, nominal, through 180 days post-fertilization (dpf) in both parental (P) and first filial (F1) generations. Histopathological analysis indicated the highest PFOS exposure (100 µg/L,

nominal) caused significantly increased incidences of lipid-type hepatocellular vacuolation in both P and F1 generations relative to controls with more prevalent and extensive effects in the F1 generation. RNA sequencing (RNAseq) analysis identified an increased number of transcripts significantly affected in PFOS exposures relative to controls in the F1 (955) versus the P generation (103), where both generations had most effects at the highest PFOS exposure (100 µg/L, nominal). Histopathological observations of disrupted lipid phenotypes in liver corresponded with transcriptomic identification of significantly enriched metabolic pathways underlying lipid metabolism, including cholesterol biosynthesis and the peroxisome proliferator-activated receptors (PPAR) pathway in both generations. To integrate these observations, an adverse outcome pathway (AOP) was developed linking the molecular initiating event (MIE) of a representative chemical stressor (PFOS), binding-initiated interference of PPAR nuclear signaling to disrupted lipid metabolism, lipid accumulation in liver, and ultimately the liver steatosis adverse outcome (AO).

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## Time-resolved multi-omics reveals staged mitochondrial dysfunction and neurodegeneration-related changes in a tri-culture BTX neurotoxicity model

Toxicology 2026 May 21 · 21 May 2026

Simultaneous benzene, toluene, and xylene (BTX) exposure is a common phenomenon in the workplace and the environment, but has not been well defined by time-resolved molecular events leading to BTX-induced neurotoxicity in multicellular settings. To address these points, we derived an in vitro tri-culture system using SH-SY5Y with a supportive glial compartment (HMC3 + U87) and combined dose-dependent phenotypic profiling with time-resolved transcriptomic, proteomic and metabolic studies after 4, 12, 24, 36 and 48 hours of BTX treatment. Working concentrations (IC10, IC20 and IC30) were determined at the end of an initial 24h dose-response step. Although BTX reduced cell viability in both monoculture and co-culture models, no significant differences in viability were observed between the two models at matched doses. Conversely, the co-culture model had increased sensitivity to sub-lethal toxic responses, which was evidenced by the higher levels of ROS and more obvious concentration-dependent responses to inflammatory, injury and the apoptosis-related markers. Transcriptional pathway dynamics were shown through time-course transcriptomics: initial enrichment of the cell cycle, DNA replication, and p53 signaling; mid-stage metabolic re-programming consisting of HIF-1 signaling, glycolysis/gluconeogenesis and pentose phosphate pathway; and later-stage enrichment of oxidative phosphorylation and Parkin pathways. Time-course proteomics and metabolomics respectively indicated a temporal shift into mitochondrial energy dysfunction, proteostasis dysregulation, and neurodegeneration-associated modules. The integrative multi-omics analysis revealed oxidative phosphorylation, Parkinsonism, and thermogenesis as the convergent pathways. Additional evidence of early transcriptional compensation followed by a reduction of mitochondrial and neurofunctional proteins was obtained by time-resolved qPCR and western blot validation. Such results indicate a sequence of BTX neurotoxicity and provide a biologically meaningful multi-omics scheme to study mechanisms underlying and identify biomarkers.

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## Pre-existing liver dysfunction modulates di-(2-ethylhexyl) phthalate (DEHP)-associated biological responses through host-microbiome networks

Environmental pollution (Barking, Essex : 1987) 2026 May 23 · 23 May 2026

Pre-existing metabolic conditions may profoundly alter biological responses to environmental pollutants, yet this dimension remains underexplored in environmental health. This study examined whether pre-existing metabolic dysfunction-associated steatotic liver disease (MASLD) is associated with altered biological responses to di-(2-ethylhexyl) phthalate (DEHP), a ubiquitous plasticizer. In a human cohort, fatty liver status was associated with altered urinary DEHP metabolite profiles, characterized by a higher proportion of the bioactive mono-(2-ethylhexyl) phthalate, suggesting disease-associated differences in DEHP biotransformation. Using a rat model and multi-omics approaches, we observed that hepatic lipid accumulation was associated with higher systemic DEHP burden and altered tissue distribution, with increased accumulation in the liver and intestine. Under this dual stress, DEHP exposure was associated with perturbations in key metabolic pathways, including amino acid, lipid, and drug metabolism. Transcriptomic analysis revealed upregulation of genes involved in fatty acid synthesis and cholesterol metabolism, consistent with enhanced hepatic lipogenesis. Concurrently, gut microbiota dysbiosis intensified, characterized by shifts in microbial community composition, including reduced Firmicutes and Bacteroidota and altered genus-level taxa linked to host metabolic and inflammatory responses. Integrative multi-omics analysis indicated possible coordinated alterations across the microbiome, metabolome, and hepatic transcriptome, potentially involving lipid metabolism and inflammatory signaling pathways. Taken together, these findings suggest that pre-existing MASLD may exacerbate DEHP-associated biological responses through pathways involving the gut-liver axis, highlighting host metabolic status as an important consideration in interpreting chemical-associated biological responses.

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