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Editorial: Unraveling the health impacts of toxic exposures

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Editorial on the Research Topic
Unraveling the health impacts of toxic exposures

Toxic exposures remain a major global health concern, particularly in tropical regions where environmental and occupational challenges intensify their impact. This editorial highlights a broad spectrum of toxic agents, including heavy metals, industrial chemicals, pesticides, air pollutants, food additives, household and water contaminants, biological toxins, pharmaceuticals, radiation, and emerging nanomaterials. The eight studies featured in this Research Topic jointly advance our understanding of the complex mechanisms underlying toxic injuries and illnesses, while emphasizing the need for improved preventive strategies, diagnostic approaches, and therapeutic interventions to mitigate their health and environmental consequences.

Investigating toxic exposures is a relevant subject specially on how these compounds play their roles in cells and tissues, and has gained attention nowadays. Chemical compounds, particularly aromatic solvents, have been extensively studied due to their widespread industrial use, physicochemical stability, and potential toxicological and environmental impacts. One example is Benzene, which is a ubiquitous environmental carcinogen linked to leukemia. Considering this, Gou et al. conducted a comprehensive analysis of the distribution patterns and trends of occupational benzene poisoning cases, recognizing that chronic benzene poisoning remains a significant occupational health issue in China, particularly among workers with occupational benzene exposure. Their study included 176 cases diagnosed with occupational chronic benzene poisoning, via the Occupational Disease Direct Network Reporting System of the Sichuan Center for Disease Control and Prevention from 2005 to 2019 with data on gender, date of birth, years of benzene exposure, enterprise size, ownership type were collected and analyzed providing evidence that in terms of age or benzene exposure duration, a linear regression analysis indicated that the number of workers increased with year, the working duration of benzene exposure appeared to decline but it was not statistically significant. These findings highlight the need to strengthen workplace monitoring of benzene concentrations and to implement targeted preventive measures to effectively safeguard workers' health.

In another study, Tsujino et al. conducted pioneering research to elucidate the effects of sodium fluoride (NaF) on platelet energy metabolism, function and viability. The study revealed that NaF significantly reduced platelet viability and inhibited platelet functions. Moreover, NaF decreased mitochondrial membrane potential and increased the production

of reactive oxygen species (ROS), indicating that even at relatively low concentrations, NaF has the potential to impair platelet function. These results suggest that when NaF is used topically, for instance, in the oral cavity to prevent dental caries, it may interfere with wound healing and tissue regeneration.

Continuing with the topic of tissue exposure and its consequences, Li et al. conducted a detailed analysis of how exposure to deltamethrin, a synthetic pyrethroid pesticide, can lead to liver damage, oxidative stress, inflammation, and metabolic disorders in aquatic animals such as the Japanese flounder (*Paralichthys olivaceus*). The authors observed a positive correlation between residual deltamethrin levels and exposure concentrations. They also detected varying degrees of damage to the gill and liver tissues of *P. olivaceus*. Histological examination revealed pronounced swelling, apical fusion, shedding of gill secondary lamellae, hepatocellular necrosis, and nuclear vacuolization, leading to the conclusion that deltamethrin induces oxidative stress and metabolic disorders in *P. olivaceus*, ultimately resulting in inflammation.

Among pesticides, beyond elucidating their specific cellular and tissue-level mechanisms, epidemiological analyses are also essential to systematically collect and interpret large sets of clinical cases. Zheng et al. conducted an epidemiological study on pesticide poisoning in Quzhou City between 2015 and 2022, identifying 2,368 confirmed cases, of which 280 were fatal, corresponding to a case-fatality rate of 11.82%. The fatality rate was higher among males (13.35%) than females (10.03%) and increased with age. Regarding pesticide classes, insecticides accounted for 66.05% of poisoning cases, followed by herbicides (20.82%) and rodenticides (9.71%). This study demonstrates that the true fatality rate of pesticide poisoning is considerably underestimated, with higher mortality risks observed among males, individuals over 40 years of age, and those exposed to herbicides through non-occupational routes. Still regarding pesticides, an impressive case study was conducted by Li et al., who reported a case involving a 22-year-old pregnant woman who self-administered approximately 200 mL of a diquat solution (200 g/L) in a suicide attempt. Based on clinical symptoms and elevated serum levels of myoglobin and creatine kinase, the patient was diagnosed with rhabdomyolysis, acute renal failure, and toxic encephalopathy caused by diquat poisoning (i.e., a bipyridyl herbicide with strong toxic effects). The patient subsequently developed toxic encephalopathy and experienced a spontaneous abortion but was discharged from the hospital after 37 days of intensive treatment. This case underscores the severe systemic toxicity of diquat, particularly its potential to induce multi-organ dysfunction and neurological damage, emphasizing the need for early diagnosis and aggressive supportive therapy in similar poisoning incidents.

Among toxic compounds, certain plants produce bioactive substances that pose significant health risks. Studying their distribution, chemical properties, and mechanisms of toxicity is crucial not only for preventing poisonings but also for advancing pharmacological and therapeutic research. Rodríguez-Guerrero et al. reported, for the first time, a case of *Pascalia glauca* poisoning in a pediatric patient. The 6-year-old boy developed tonic–clonic seizures, altered consciousness, vomiting, and a Glasgow Coma Scale score below 8. The patient was treated with anticonvulsants, including levetiracetam; however, laboratory findings revealed markedly elevated transaminases and coagulopathy that did not improve with vitamin K administration. These findings led to a diagnosis of acute liver failure. After 27 days in the pediatric intensive care unit, the patient was transferred to the general ward hemodynamically stable but unable to speak or respond to stimuli. This first documented case of human poisoning by *P. glauca* underscores the plant's potential neurotoxic and hepatotoxic effects, highlighting the importance of raising awareness among healthcare professionals and the need for further toxicological research.

The petrochemical industry exposes workers and nearby communities to toxic substances such as volatile organic compounds, heavy metals, and polycyclic aromatic hydrocarbons. These exposures can result in respiratory, neurological, and carcinogenic effects, while also contaminating air, water, and soil. Assessing and managing these risks is essential to protect human health and to promote safer, more sustainable industrial practices. Therefore, identifying biomarkers of exposure and developing predictive models for toxicity require a thorough understanding of the underlying epigenetic mechanisms. Jayaraman et al. highlighted specific epigenetic processes, particularly gene-specific DNA methylation changes associated with prolonged petrochemical exposure, in a high-impact review. They concluded that refining disease modeling, developing comprehensive risk assessment frameworks, and advancing targeted therapeutic strategies depend on enhancing exposure evaluation, leveraging computational tools to analyze molecular alterations, and deepening our understanding of how these changes influence disease prevention and treatment.

Globally, millions of workers are exposed to hazardous substances each year through occupational activities, contributing to an estimated 2.3 million deaths annually. Understanding exposure pathways is therefore critical for implementing effective risk mitigation strategies. Kayser et al. in their review, provided practical insights and recommendations for selecting suitable occupational exposure models in the biopharmaceutical industry to support the new "light-speed" pace of process development, scale-up, and manufacturing. They evaluated seven occupational exposure models, identifying key mechanisms ranging from simple, highly conservative control banding tools and heuristic algorithms to multiplying-factor-based and mass-balance models. The authors emphasized that as occupational exposure models become more predictive, they also increase in complexity and require greater expertise for proper use and interpretation.

Collectively, this Research Topic underscores the remarkable breadth of contemporary toxicological research, uniting studies that encompass industrial, environmental, and biological toxicants. These investigations advance our understanding of how diverse agents, from benzene and pesticides to petrochemicals and toxic plants, disrupt molecular, cellular, and systemic functions. By integrating epidemiological evidence, mechanistic insights, and predictive modeling, the Research Topic emphasizes the urgent

need for stronger preventive strategies and translational approaches to mitigate the global health burden of toxic exposures.

Author contributions

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