Global Environmental Science
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Viewpoint

Who are the "Culprits": Environmental Health Alert from the Lead Poisoning Incident at a Kindergarten in Tianshui, Gansu, China

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How To Cite: Liu, H.; Qiu, T.; Zhao, L.; et al. Who are the "Culprits": Environmental Health Alert from the Lead Poisoning Incident at a Kindergarten in Tianshui, Gansu, China. *Glob. Environ. Sci.* **2026**, *2*(1), 38–42. https://doi.org/10.53941/ges.2026.100003

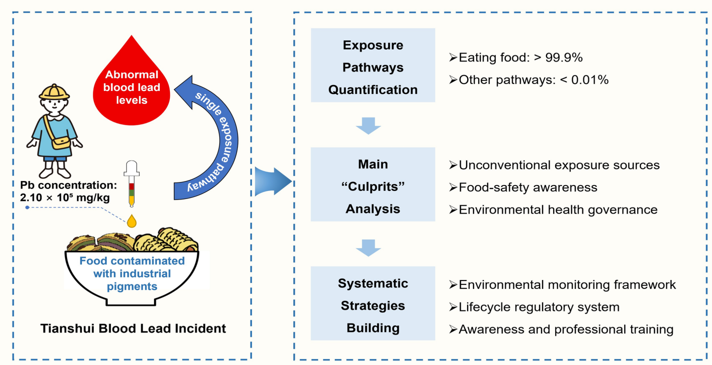
Publication History
Received: 18 October 2025
Revised: 12 December 2025
Accepted: 18 December 2025
Published: 23 December 2025

Keywords
heavy metals;
children exposure;
exposure pathway;
lead poisoning incident;
health risk

Highlights

- Exposure pathway of this incident was contaminated food by industrial pigments
- "Culprits": Unregulated pigments, food safety, environmental governance
- Strategies: targeted monitoring, traceability systems, targeted safety training

Abstract: The blood lead (Pb) poisoning incident at a kindergarten in Tianshui, Gansu, China in July 2025, underscores the persistent challenge of heavy metal exposure among vulnerable populations. Despite strengthened global controls on heavy metals such as Pb, environmental residues and diverse exposure pathways continue to pose health risks, particularly to children with developing nervous systems. The abnormal blood Pb levels in the affected kindergarten children were almost entirely (>99.9%) attributable to a single exposure pathway: consumption of food contaminated with industrial pigments. The severity of this incident was intensified by three main "culprits": inadequate oversight of unconventional pollution sources, insufficient food safety awareness, and poorly coordinated environmental health governance. Effective prevention requires a comprehensive approach: enhanced monitoring of child-centric environments, interdisciplinary risk assessment, lifecycle regulation of heavy metal-containing products, and science-based public awareness campaigns. We propose a targeted monitoring framework for kindergartens in historically contaminated regions, including quarterly soil/dust Pb testing, semi-annual air quality assessments, and annual blood Pb screening of children, supported by a digital traceability system for industrial pigments. Protecting children from such hidden threats demands systematic and collaborative action across research, governance, and society.



1. Incident Background

In July 2025, 247 children and 28 staff members from a kindergarten in Tianshui city, Gansu, China, were found to have abnormal blood Pb levels (100 < Pb ≤ 528 μg/L) (hereafter termed as "this incident" for simplicity) (https://www.chinadailyhk.com/hk/article/616314 (accessed on 21 July 2025)). Located in a region with a long history of non-ferrous metal mining and smelting, Tianshui has been experiencing industrial heavy metal pollution for decades. This incident once again drew public attention to Pb poisoning in Gansu Province, where similar outbreaks had occurred in 2006 in Longnan and Tianshui due to industrial pollution from local smelters. According to the official investigation report released on 20 July 2025, the source of contamination was not environmental but the kindergarten's own food: the chef mixed non-food industrial pigments into flour to make corn rolls and three-color red dates cake to improve their appearance. Official tests revealed that two food samples contained Pb levels of 1050 mg/kg and 1340 mg/kg, far exceeding the national safety limit (0.5 mg/kg), and the concentrations of Pb in the red, green and yellow pigments were 5.96, 13.7 and 2.10 × 10^5 mg/kg, respectively. The inquiry also revealed that both the local hospital and the Center for Disease Control and Prevention had tampered with blood-Pb test results, downplaying the severity of the poisoning. Six kindergarten employees, including the principal and cooks, have been arrested, while 17 officials are under disciplinary review for dereliction of duty and covering up the incident.

This incident once again drew the public's attention to the issue of children's heavy metal exposure and alarm bell for the prevention of corresponding health risks. Many heavy metals have strong neurotoxicity and developmental toxicity, among which the damage of Pb to the central nervous system of children is particularly irreversible [1]. Although the global mining and use of certain heavy metals have been strictly regulated over the past decades (e.g., the ban on Pb-based gasoline and paints in consumer products), their residues in the environment and unintended exposure pathways have not yet been fully recognized and comprehensively controlled [2,3].

2. Multi-Pathways Exposure Characteristics of Heavy Metals in Children

Children, due to their physiological characteristics and behavioral habits (e.g., frequent hand-to-mouth activities, higher respiratory rates, lower body weight, and more vulnerable intestinal barriers), are more susceptible to being exposed to heavy metals through multi- pathways and eventually enter the body via inhalation, ingestion, and dermal contact three routes (Figure 1) [4]:

- Atmospheric particulate matter: Emissions from industry, coal burning, and vehicles deposit metals like Pb onto fine particles. Children inhale a greater volume of air per kilogram of body weight due to higher breathing rates, which, combined with their developing lungs, leads to increased metal absorption into the bloodstream. Inhalation of $PM_{2.5}$-bound Pb is associated with neurodevelopmental deficits, respiratory inflammation, and potential cardiovascular effects in children [5]. The Pb concentration in the air samples taken around the kindergarten was between 0.006 μg/m^3 and 0.03 μg/m^3, which was lower than the limit value stipulated in the environmental air quality standards of China (GB 3095-2012).
- Drinking water and eating food: The old water plumbing, industrial waste or contaminated soil introduce metals into drinking water and food. Children ingest these metals through daily dietary intake, with higher absorption efficiency due to their developing gastrointestinal tract and even enter the bloodstream. Waterborne Pb exposure can cause renal impairment and hypertension, while dietary exposure, as demonstrated in this incident, can lead to acute toxic effects, including gastrointestinal distress, anemia, and severe neurological damage [6]. Notably, investigation results of this accident confirmed that lead levels in the contaminated food samples exceeded national safety standards by several thousand-fold, establishing dietary intake as the dominant exposure route and causing acute poisoning in affected children. In contrast, Pb concentrations in surface water (0.92 μg/L) complied with national standards (GB 3838-2002), and no lead was detected in groundwater.
- Soil and dust: Historical industrial pollution and e-waste dismantling can lead to the accumulation of heavy metals in the soil and dust of the sites. Children are prone to ingesting these metals through frequent hand-to-mouth contact [7,8]. Soil and dust ingestion can cause gastrointestinal absorption of heavy metals, potentially leading to cognitive deficits and behavioral problems. The official investigation results show that the Pb concentration in the soil around the kindergarten was 24.6 and 27.6 mg/kg, respectively. These levels are within the safe range and are not the exposure source of this incident.
- Toys and other items: Low-quality toys or ceramic glazes may contain heavy metals such as Pb and Cd. Children may be exposed to these heavy metals by dermal contact and ingestion (e.g., licking, chewing or swallowing) [9]. Dermal exposure typically presents lower absorption rates than ingestion, but mouthing behaviors significantly increase ingestion risks. No evidence suggested toy-related exposure contributed significantly to this incident.

- Clothing and care products: Heavy metals such as Pb or Cd may be present in low-cost dyes, plastics, or contaminated ingredients used in these products. Children are exposed through dermal contact and frequent licking with increased risk (especially if the skin is damaged or thin), eventually reaching the blood [10]. Similar to toys, this pathway was negligible in this incident compared to the massive dietary exposure.

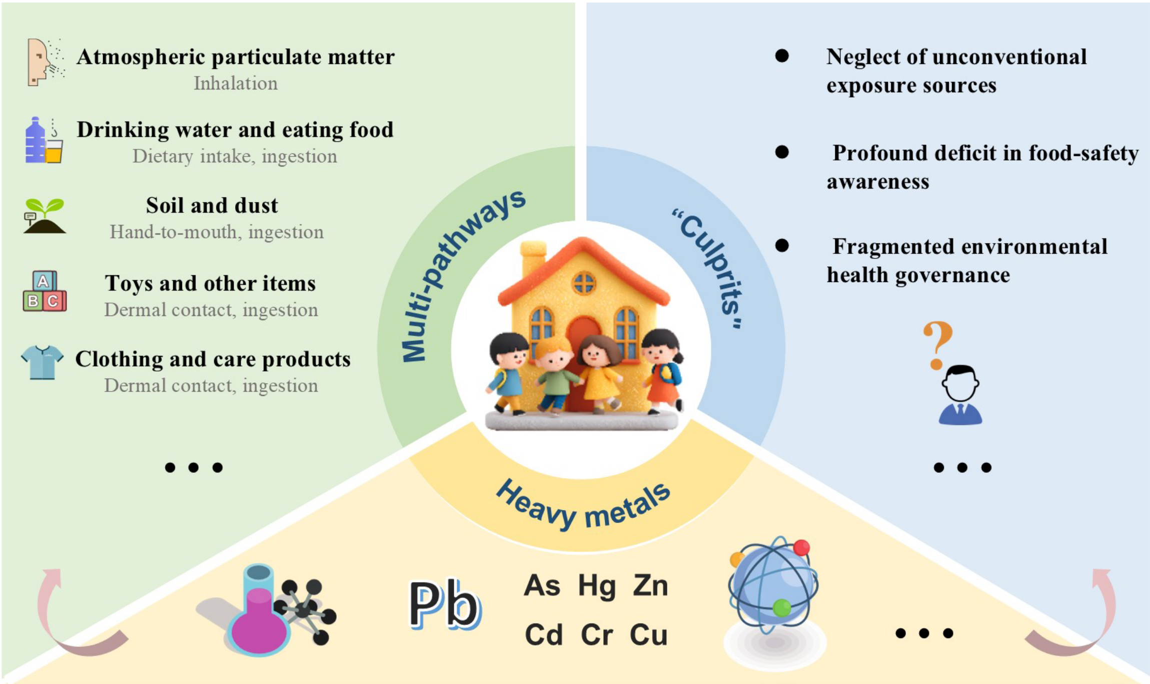


Figure 1. The common multi-pathways for children to be exposed to heavy metals and the "culprits" behind this incident of the current abnormal blood Pb level in Tianshui, China.

Based on the environmental monitoring data officially released, the estimation of Pb exposure for children along different paths showed that in this incident, abnormal blood Pb levels in children were caused by a single route—the intake of food contaminated by industrial pigments (>99.9%). The Pb concentration in the local environmental media (soil, air, water) was at a relatively low level, and its contribution to this incident could be negligible. The specific calculation can be found in Text S1 of the Supplementary Materials.

3. The Main "Culprits" Behind This Incident

In historically contaminated industrial cities, childhood heavy-metal exposure is typically attributed to mining and smelting activities. However, in this incident, the overlooked exposure sources, the weak awareness of food safety, and the systematic mistakes in environmental management were the main "culprits" (Figure 1):

- Neglect of unconventional exposure sources: The unauthorized use of industrial Pb-based pigments in food processing during this incident highlights regulatory blind spots regarding non-traditional pollution sources (e.g., decorative materials, toy coatings, and historical contamination residues). There is a lack of systematic environmental monitoring for heavy metals in and around child-dense venues such as kindergartens and schools. In Tianshui, this blind spot was exacerbated by the region's focus on conventional industrial pollution sources, causing authorities to overlook the threat from intentionally adulterated food products.
- Profound deficit in food-safety awareness: The kindergarten knowingly incorporated pigments intended for industrial use into food items, evidencing an extreme deficiency in institutional responsibility and risk perception. Mandatory safety trainings and management protocols existed only nominally. The absence of routine food ingredient verification and lack of awareness about heavy metal toxicity in non-food products created conditions for this preventable tragedy.
- Fragmented environmental health governance: Coordination among environmental, educational, and market-supervision authorities was ineffective, precluding risk early-warning and information exchange. Environmental monitoring, biomonitoring, and health data remained siloed, obstructing timely intervention. In Tianshui, this fragmentation was evident when environmental agencies focused on external pollution while educational departments neglected food safety oversight, and health authorities failed to accurately report clinical findings.

 https://doi.org/10.53941/ges.2026.100003

In addition, inadequate regulatory oversight and non-standardized clinical testing further amplified the severity of the event.

4. Systemic Strategies for Preventing Heavy Metal Exposure in Children

Although standard limits for major heavy metals have been established for environmental media such as air and water, it is increasingly recognized that no safe threshold for heavy metal exposure, especially in children. Even low-dose, long-term Pb exposure has been linked to developmental delays, attention deficits, and behavioral abnormalities [6,11]. Concurrently, children's disease patterns have shifted significantly in recent decades alongside improvements in living conditions [12]. While traditional threats from contaminated drinking water and poor sanitation have declined [5], new challenges have emerged. Modern food distribution systems, for example, have altered dietary habits and may introduce novel exposure pathways [12]. Moreover, previous research has largely focused on children in heavily contaminated areas, overlooking regions without obvious pollution sources where residual contamination and inadequate public health systems still pose risks. Thus, a comprehensive approach addressing diverse exposure pathways and heavy metals' chronic, cumulative effects is essential to effectively prevent childhood exposure.

The blood Pb anomaly in Tianshui, Gansu, China, is not an isolated tragedy but a stern warning to the entire society's prevention system for health risk from environmental contaminants. The "culprits" often hide in our surrounding environment, as they may be historical legacies, or regulatory blind spots [13], and identifying these "culprits" requires a scientific detective spirit. It is necessary to strengthen the monitoring and assessment of the environment around children's dense places, such as kindergartens, schools, and high-risk areas (e.g., historical industrial zones, major traffic routes, and old residential communities) [14]. Eliminating these "culprits" requires establishing a multi-department collaborative environmental health risk assessment mechanism, combining biomonitoring (such as blood Pb screening), environmental monitoring, and epidemiological surveys to systematically identify exposure sources and implement targeted intervention measures. Based on the lessons learned, we propose the following specific, actionable strategies for preventing childhood heavy metal exposure, particularly relevant to historically industrialized regions like Tianshui:

(1) Enhanced Environmental Monitoring Framework for Child-Centric Spaces

- Implement mandatory quarterly soil and dust heavy metal testing (e.g., Pb, Cd, Hg, As) within a 500 m radius of all kindergartens and schools in historically contaminated regions;
- Conduct semi-annual air quality assessments specifically measuring $PM_{2.5}$-bound metals during different seasons;
- Establish a digital monitoring platform integrating environmental data with children's health records to identify emerging threats.

(2) Lifecycle Regulatory System for Heavy Metal-Containing Products

- Create a specialized licensing system for industrial pigments and chemicals with potential for misuse in food products, requiring distributors to maintain detailed sales records;
- Implement QR code traceability for industrial chemical containers to track distribution and prevent diversion to unauthorized uses;
- Establish a multi-departmental task force (environmental protection, market regulation, education, health) with clear accountability mechanisms and mandatory data sharing protocols.

(3) Evidence-Based Public Awareness and Professional Training

- Develop targeted educational programs for kindergarten staff and food handlers, focusing on heavy metal hazards and safe ingredient sourcing;
- Create public awareness campaigns about potential heavy metal exposure pathways, leveraging community health workers and digital platforms;
- Implement mandatory food safety certification for all kindergarten kitchen staff with specific modules on chemical hazards.

These strategies draw on successful international models, such as the U.S. EPA's Lead Awareness in Kindergarten program and the European Union's SCIP database for tracking substances of concern, while adapting them to the Chinese context with specific implementation timelines and responsible agencies.

Protecting children from the hazards of heavy metal exposure is a systematic project that requires the joint efforts of the government, enterprises and the public. Only through a combination of scientific source tracing, systematic intervention, and public education can we fundamentally safeguard children from the threat of heavy metal exposure.

Supplementary Materials

The additional data and information can be downloaded at: https://media.sciltp.com/articles/others/2512221549559433/GES-25100085-Supplementary-Materials.pdf.

Author Contributions

H.L.: Writing—original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation; T.Q.: Formal analysis, Data curation, Visualization; L.Z.:

Writing—review & editing; Z.C.: Writing—review & editing, Supervision, Project administration, Investigation, Funding acquisition, Conceptualization; T.A.: Writing—review & editing, Methodology. All authors have read and agreed to the published version of the manuscript.

Funding

This work is supported by the National Natural Science Foundation of China (42507498, 42477473, U25A20825), the Postdoctoral Fellowship Program of CPSF (GZC20250845), the China Postdoctoral Science Foundation (2024M760833), the Huanghuai Lab Sci-Tech Innovation Project (240700008), and the Natural Science Foundation of Henan Province (252300421080).

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare that they have no conflicts of interest in this work. Given the role as Editor-in-Chief, Taicheng An had no involvement in the peer review of this paper and had no access to information regarding its peer review process. Full responsibility for the editorial process of this paper was delegated to another editor of the journal.

Use of AI and AI-Assisted Technologies

During the preparation of this work, the authors used DeepSeek to polish the language. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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