Research Article

Lead Toxicity Testing in the Asia-Pacific - Practices, Challenges, and Policy Insights: An APFCB Communication and Publications Committee Survey report

Vivek Pant[1,7], Deepak Parchwani[2,7], Mayank Upadhyay[3,7], Ryunosuke Ohkawa[4,7], Mingma Lhamu Sherpa [5,7], Pradeep Kumar Dabla[6,7*]

[1]*Department of Biochemistry, Samyak Diagnostic Pvt Ltd, Kathmandu, Nepal*
[2]*Department of Biochemistry, All India Institute of Medical Sciences, Rajkot, Gujarat, India*
[3]*Asia Pacific Regional Marketing Manager – Clinical Laboratory Assays for Quidel Ortho*
[4]*Department of Clinical Bioanalysis and Molecular Biology, Graduate School of Medical and Dental Sciences, Tokyo*
[5]*Department of Biochemistry, Sikkim Manipal Institute of Medical Sciences, India*
[6]*Department of Biochemistry, G.B.Pant Institute of Postgraduate Medical Education & Research, Delhi, India*
[7]*APFCB Communication and Publications Committee*

Article Info

Corresponding Author:
Pradeep Kumar Dabla
Chair, APFCB Communication and Publications Committee
E-mail: pradeep_dabla@yahoo.com

Keywords

Lead toxicity, Lead testing, APFCB C-CP, Asia-Pacific, Occupational exposure, Environmental contamination, Policy recommendations

Abstract

Background: Lead exposure remains a major health concern in the Asia-Pacific, particularly affecting children. Despite its significance, lead toxicity testing is underutilized because of limited awareness, resources, and policy support. On December 16, 2024, the APFCB C-CP (Asia-Pacific Federation for Clinical Biochemistry and Laboratory Medicine -Communication and Publications Committee) conducted Webcast & eLearning Program Webinar themed as "Protecting Health in Asia-Pacific: Laboratory Advances and Lead Exposure Prevention", aimed to address these issues and acknowledge need based solutions. An online survey was conducted during webinar in real time to assess the current lead-testing practices, common exposure sources, testing challenges, and policy changes.

Methods: A seven-question survey was distributed to webinar participants, covering testing frequency, methodologies, exposure sources, information sources, challenges, and policy needs. A total of 66 professionals attended the session and 22 complete surveys were collected from Nepal, India, Indonesia, Japan, and Australia.

Results: Lead testing was infrequent in the region, with 58.6% of the respondents reporting rare or no testing. Weekly testing has been reported in 20.7% of cases. The most commonly used methodology was point-of-care testing via anodic stripping voltammetry (37.5%) followed by electrothermal atomic absorption spectrometry (25%). Occupational exposure (39.1%) was the leading source of lead poisoning, followed by dietary sources (26.1%) and environmental contamination (21.7%). Academic journals (47.5%) were the primary educational resources. Key challenges included low awareness among healthcare providers (43.5%) and resource shortage (39.1%). The most recommended policy change was to increase government support (61.5%).

Conclusion: In conclusion, lead testing remains infrequent across many settings, with limited routine implementation and heavy reliance on point-of-care methodologies. Occupational exposure emerged as the predominant source of lead poisoning, underscoring the need for targeted interventions. Strengthening government support is identified as the most critical policy change to enhance lead testing and management efforts.

Background

Lead exposure remains a major public health concern in many regions, particularly in the Asia-Pacific, where its effects on vulnerable populations especially children are profound [1]. Despite its significance, lead toxicity testing is often underutilized because of limited awareness, resource constraints, and insufficient policy frameworks [1, 2]. Biomonitoring practices and identification of lead exposure pathways vary widely across countries. High-income nations have implemented comprehensive regulations addressing legacy lead sources, such as lead-based paint, water plumbing systems, and other environmental hazards [3]. While several countries have established regulatory frameworks that have contributed to reduced lead exposure, only a few have developed robust policies for laboratory diagnosis and routine blood lead level (BLL) testing [4]. There is a pressing need for international harmonization of stepwise laboratory diagnostic protocols to ensure consistency in the detection and management of lead poisoning.

Current lead testing and detection methods may not fully align with the evolving demographics and exposure patterns [5]. According to the Centers for Disease Control and Prevention (CDC), initial screening can be performed using a point-of-care device to analyze a capillary blood sample [6]. If the screening result is negative, further testing is typically unnecessary, unless clinically indicated. However, if a positive result is obtained; confirmatory testing using venous blood lead level measurement is required for definitive diagnosis. Venous samples are analyzed in laboratories using validated methods, such as graphite furnace atomic absorption spectroscopy (GFAAS), atomic absorption spectroscopy (AAS), and inductively coupled plasma mass spectrometry (ICP-MS). Strengthening biomonitoring efforts and improving data collection on exposure pathways would enhance our understanding of lead sources and enable more targeted prevention strategies.

One of the critical challenges is the lack of public awareness of low-level lead exposure. Although public health experts stress the importance of minimizing population-wide lead exposure, this issue remains under-recognized by laboratory professionals and the general public. Bridging these gaps through increased advocacy, improved diagnostic capabilities, and stronger policies is essential for effective lead exposure mitigation.

To address these pressing concerns, the Asia-Pacific Federation for Clinical Biochemistry and Laboratory Medicine Communication and Publications Committee (APFCB C-CP) conducted a Webcast & eLearning Program Webinar on December 16, 2024, themed as "Protecting Health in Asia-Pacific: Laboratory Advances and Lead Exposure Prevention" [7]. As part of the initiative, a survey questionnaire was developed to gather insights from the participants. The online survey aimed to assess the current lead testing methodologies used in laboratories across the region, identify common causes of elevated blood lead levels, highlight challenges in testing, and determine necessary policy changes recommended to improve the lead exposure prevention and management.

Methods

A structured questionnaire comprising seven closed ended questions was developed to gather insights from webinar participants regarding lead toxicity testing and related challenges in clinical laboratories across the Asia-Pacific region. Participants could select multiple options. The questionnaire was designed to be concise and focused to ensure clarity and encourage higher response rates [7]. These questions were developed based on a review of the relevant literature and consultation with relevant experts and Team APFCB C-CP. The questionnaire was then reviewed and approved by an independent expert in laboratory medicine and expert feedback was incorporated to refine the questionnaire before its release. The survey questions (Supplementary 1) focused on the following key areas.

1. Geographical distribution: Participants were asked to specify their country of practice to assess regional representation in the responses.
2. Lead testing Frequency – Respondents were asked to provide details on how often their laboratory conducts lead level testing, helping to evaluate testing accessibility and demand.
3. Testing methodologies: The survey gathered information on the laboratory techniques used for lead analysis, including atomic absorption spectrometry, inductively coupled plasma mass spectrometry, CLIA-waived point-of-care devices, and other methods to examine variations in testing practices.
4. Common Sources of lead exposure: Participants were asked to identify the most frequently observed sources of lead exposure among their patients, including occupational exposure, environmental contamination, dietary sources such as herbal remedies, and household items such as toys, to gain a broader understanding of regional exposure patterns.
5. Sources of Information on lead poisoning: Respondents were required to indicate how they acquired knowledge about lead poisoning, such as through academic literature, webinars and workshops, government guidelines, or news and social media, to assess key information dissemination channels.
6. Challenges in implementing lead testing: The questionnaire explored the barriers laboratories face in conducting lead toxicity testing, including resource limitations, regulatory challenges, and lack of awareness.

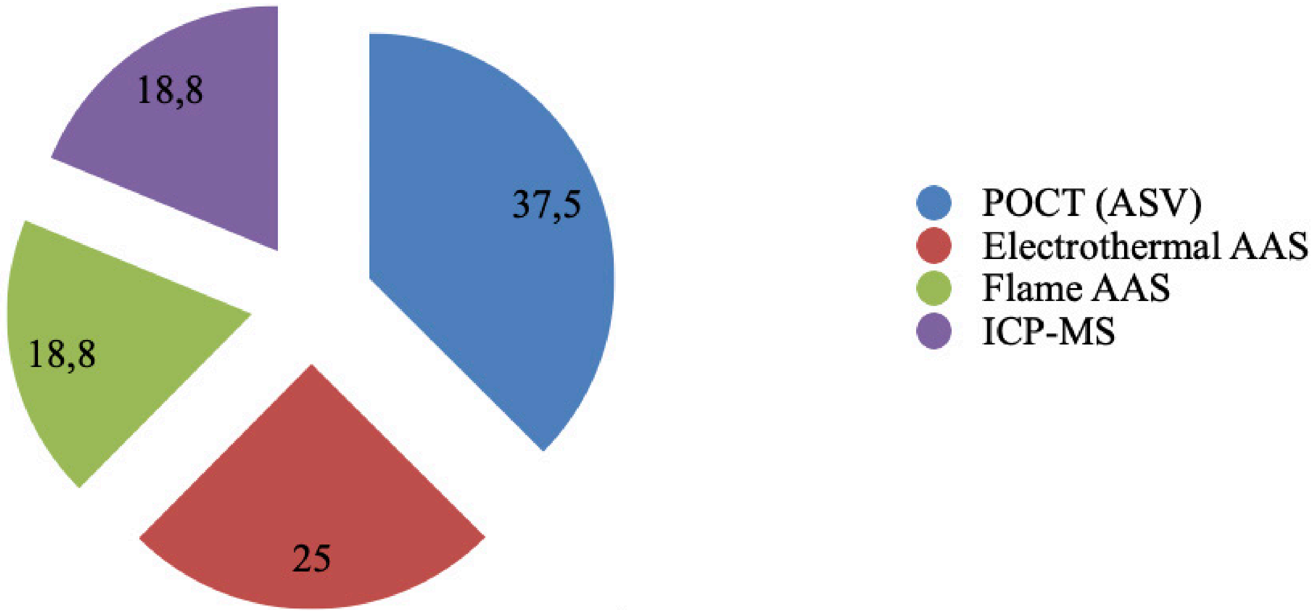
7. Policy recommendations: Participants were asked to share their perspectives on the policy changes needed to enhance lead screening, diagnosis, and management. Suggested improvements include increased government support for testing, stricter regulations on lead exposure, better training for healthcare workers, and greater assistance from international organizations.

The questionnaire was disseminated electronically during the webinar, allowing for real-time participation. A total of 66 professionals attended the session, representing various laboratories across the Asia-Pacific region. Of these, 22 participants from five countries Nepal, India, Indonesia, Japan, and Australia submitted complete responses. This study ensured strict anonymity and confidentiality of the collected data. Data were summarized using descriptive statistics, and all analyses were performed using Microsoft® Excel® 2019

Results

Lead testing is infrequent in the region, with 58.6% of laboratories reporting that they rarely or never perform it. Weekly testing was the second most common method (20.7%). The most commonly used methodology is point-of-care testing via ASV (anodic stripping voltammetry), followed by electrothermal atomic absorption spectrometry (Figure 1).

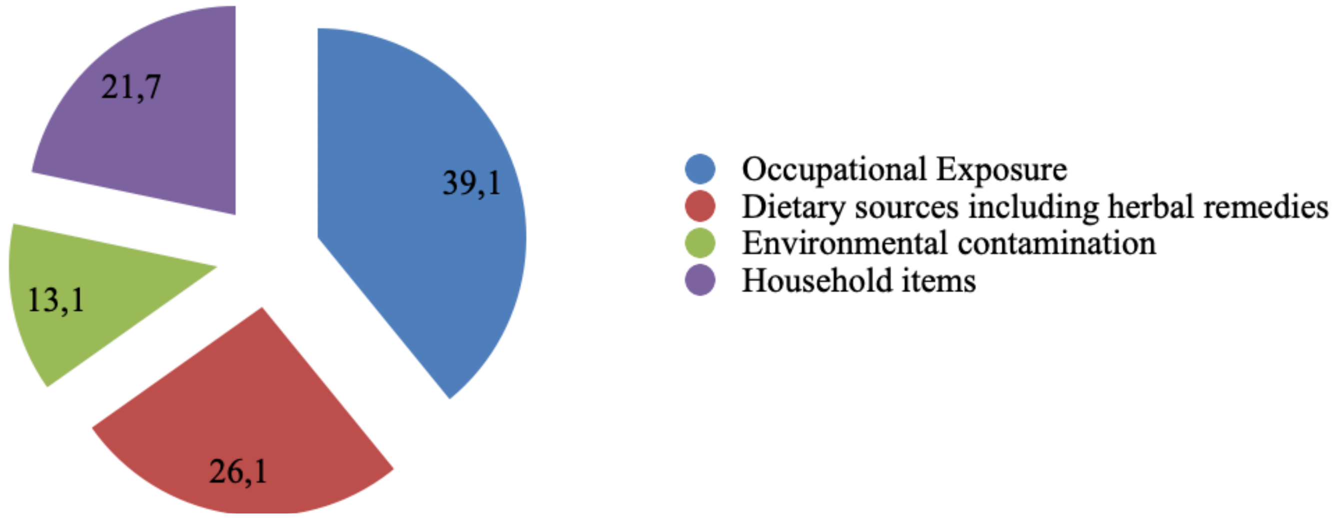
Figure 1: Commonly used methodologies to analyze blood lead level in Asia Pacific region.



Abbreviation: ASV-Anodic Stripping Voltammetry, POCT- Point of Care Testing, AAS- Atomic Absorption Spectrometry, ICP-MS- Inductively Coupled Plasma Mass Spectrometer

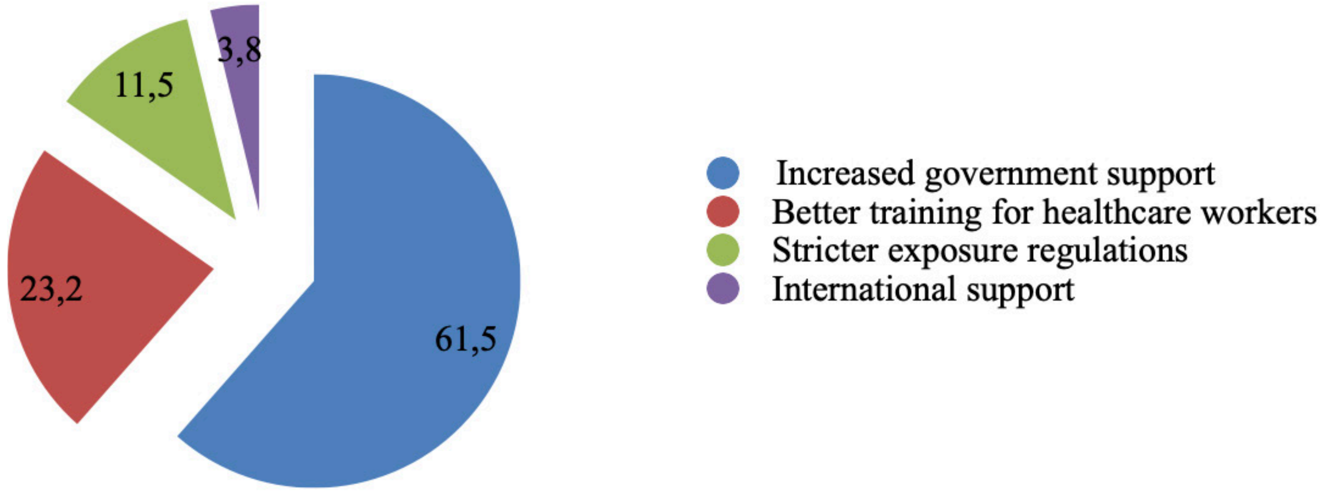
Occupational exposure was the most common cause of lead toxicity, as indicated by the participants, followed by dietary sources, including herbal remedies (26.1%) (Figure 2).

Figure 2: Commonest cause of lead toxicity in Asia Pacific region as pointed by the participants.



Academic journals were the primary source of information on lead poisoning (47.5%), followed by workshops/webinars and government health resources (15% each). News articles and social media were less utilized. Key challenges in lead testing included lack of awareness among healthcare providers (43.5%) and resource shortages (39.1%). The most commonly suggested policy improvement included increased government support (61.5%) (Figure 3).

Figure 3: Participants perspectives on policy changes needed to enhance lead screening, diagnosis, and management.



Discussion

The findings of this survey highlight several critical challenges in the implementation of lead toxicity testing across the Asia-Pacific region. One of the most notable issues is the limited frequency of lead testing, which suggests that many healthcare facilities either lack the necessary infrastructure or do not prioritize lead-level screening as part of routine diagnostics. This gap in testing accessibility may lead to under diagnosis and missed opportunities for early intervention in cases of lead exposure. An estimated one-third of children worldwide have elevated BLL, contributing to cognitive impairment and increased cardiovascular risk [8]. The lack of widespread BLL testing prevents accurate assessment of exposure and limits targeted interventions. Evidence from Georgia highlights the impact of population-level testing, which has revealed previously underestimated lead poisoning rates and led to policy action [9]. Expanding BLL testing is essential for identifying high-risk populations, driving policy changes, and implementing effective lead-exposure prevention strategies. A major barrier for lead testing identified in this survey was a lack of resources, including access to appropriate testing equipment and reagents. Advanced techniques, such as Graphite Furnace atomic absorption spectrometry and inductively coupled plasma mass spectrometry, which are considered gold standards for lead testing, are not widely available in all laboratories, which might be due to high costs and technical requirements. Some laboratories may rely on alternative methods, such as point-of-care devices; however, the reliability and standardization of such approaches remain a concern [10, 11]. A study conducted in Japan found that point-of-care lead level analyzers showed a significant positive bias compared to ICP-MS at levels above 45 µg/dL [12]. Nevertheless, POCT devices based on anodic stripping voltammetry (ASV) offer rapid and accessible BLL testing, providing results in approximately three minutes from a small capillary blood sample [13]. These portable devices are essential in physician-office laboratories, regulatory-waived settings, and resource-limited areas where traditional laboratory testing is unavailable [13, 14]. Their ease of use and pre-calibrated disposable components make them effective for initial screening, though elevated results should be confirmed with laboratory-based ICP-MS or Graphite Furnace AAS testing. Portable testing devices have been essential in humanitarian crises such as the 2010 lead poisoning outbreak in Zamfara, Nigeria, where these devices allowed health workers to quickly test people on-site, leading to faster diagnosis and treatment, which helped save many lives [15]. Their ability to provide immediate results enhances their early detection and intervention, making them invaluable tools for lead exposure management in both clinical and emergency settings.

Awareness among healthcare providers regarding lead testing has emerged as a significant limitation. Clinicians and laboratory professionals may not routinely consider lead exposure in differential diagnoses, particularly in regions where lead poisoning is not commonly recognized as a public health threat. [16]. This lack of awareness can delay diagnosis and appropriate management, allowing continued exposure and worsening of health outcomes. Greater efforts are needed to educate healthcare workers about the importance of lead testing, potential sources of exposure, and the clinical manifestations of lead poisoning. Healthcare workers can be educated through targeted training programs, workshops, and continuing medical education sessions. Collaboration with public health agencies, professional associations, and laboratories can facilitate guideline dissemination and case-based learning. Additionally, hospitals and clinics can implement screening protocols and provide quick reference materials to aid diagnosis and management. Raising awareness through conferences, newsletters, and digital platforms further reinforces knowledge and encourages proactive detection and prevention of lead poisoning.

The survey also shed light on the primary sources of lead exposure reported by the participants. Occupational exposure was identified as the most common cause and this is seen particularly among workers in industries, such as battery manufacturing, metal recycling, and construction. Additionally, dietary sources, including the consumption of herbal remedies and environmental contamination, such as lead in water supplies, air pollution, and exposure to lead-based paints, have also been reported as significant contributors. A systematic review of 520 studies identified major sources of lead exposure, including informal lead-acid battery recycling and manufacturing, metal mining and processing, electronic waste, and lead adulteration in food, particularly in spices [17]. Lead exposure comes from different sources depending on the country. Cosmetics and traditional medicines are common sources in India and Nepal [18, 19]. China also has issues with electronic waste, traditional medicines, and industrial pollution [20]. Australia faces risks from paint, dust, imported toys, and traditional medicine [21]. In wealthier countries, past lead use continues to pose risks, while in lower-income countries, weak or poorly enforced regulations worsen the problem. These findings emphasize the need for targeted interventions such as workplace safety regulations, stricter monitoring of food and herbal products, and improved environmental policies to reduce lead contamination.

Although the survey included only 22 participants, they were laboratory experts specializing in heavy metal toxin analysis and research. Their insights offer a meaningful snapshot of lead toxicity testing in their regions and are valuable for guiding policy development. The limited number of respondents, even in an international webinar setting, also highlights how often this critical issue is overlooked.

To ensure effective lead toxicity testing across the Asia-Pacific region, targeted solutions are needed to address key gaps in accessibility, standardization, and awareness. Strengthening testing capacity, resources, and policies will enhance early detection, safeguard public health, and reduce lead exposure risks. Priority actions include:

1. Expanding regional representation by involving more countries.
2. Improving access to regular testing through increased funding and lab support.
3. Standardizing testing methodologies across the region.
4. Educating communities about common lead sources and promoting awareness.
5. Enhancing government guidelines and launching public awareness campaigns.
6. Streamlining regulatory processes for more efficient implementation.
7. Developing a quality assurance framework for point-of-care blood lead level testing.

Conclusion

This survey highlights the urgent need for stronger government support and policy action on lead testing. Wider access to advanced testing methods, and inclusion of laboratory professionals in decision making are essential. Beyond testing, laboratory experts play a vital role in interpretation, clinician guidance, and quality assurance and their involvement in policy development can strengthen screening programs, standardize protocols, and build laboratory capacity.

Conflict of Interest
None.

Acknowledgement
We sincerely thank all webinar participants for their valuable contributions. We present our gratitude to speaker's session Dr. Vivek Pant and Dr. Hafsa Majid for their insightful presentations and Dr. Praveen Sharma for his excellent moderation. We also appreciate Quidel Ortho for providing the online platform for the program.

Funding
None.

Authors Contribution
VP - Conceptualization, Preparation of survey questionnaire, writing manuscript
VP, DP, PKD, MU- Conducted online survey, collected results and analyzed findings
DP, MU, RO, MLS- Scientific Review
PKD- Review and approval of final version

Ethics approval and consent to participate
This study is in compliance with the ethical principles for medical research involving human subjects, in accordance with the Declaration of Helsinki. Formal ethical approval was not required, as the survey involved anonymized and voluntary responses collected during a webinar with participant consent. Surveys of this nature are exempt from ethics approval at the institution where it was conducted.

Data Availability Statements
The data generated and analyzed in the presented study are available from the corresponding author on request.

References
1. Kordas K, Ravenscroft J, Cao Y, McLean EV. Lead exposure in low and middle-income countries: perspectives and lessons on patterns, injustices, economics, and politics. International journal of environmental research and public health. 2018;15(11):2351. DOI: 10.3390/ijerph15112351
2. Champion WM, Khaliq M, Mihelcic JR. Advancing knowledge to reduce lead exposure of children in data-poor low-and middle-income countries. Environmental Science &Technology Letters. 2022;9(11):879-888. DOI: 10.1021/acs.estlett.2c00656
3. Dignam T, Kaufmann RB, LeStourgeon L, Brown MJ. Control of lead sources in the United States, 1970-2017: public health progress and current challenges to eliminating lead exposure. Journal of Public Health Management and Practice. 2019; 25:S13-22. DOI: 10.1097/PHH.0000000000000889
4. Sullivan M, Green D. Toward eliminating children's lead exposure: A comparison of policies and their outcomes in three lead producing and using countries. Environmental Research Letters. 2020;15(10):103008. DOI: 10.1088/1748-9326/abb55e
5. Deibler K, Basu P. Continuing issues with lead: recent advances in detection. European journal of inorganic chemistry. 2013;2013(7):1086-1096. DOI: 10.1002/ejic.201200997
6. Wengrovitz AM, Brown MJ. Recommendations for blood lead screening of Medicaid-eligible children aged 1–5 years: an updated approach to targeting a group at high risk. MMWR Recomm Rep. 2009;58(RR-9):1-1. https://pubmed.ncbi.nlm.nih.gov/19661858/
7. https://apfcb.org/Webcast&e-Learning Accessed on 17/02/2025
8. https://www.unicef.org/press-releases/third-worlds-children-poisoned-lead-new-groundbreaking-analysis-says Accessed on 24/02/2025
9. https://www.unicef.org/documents/ending-childhood-lead-poisoning-georgia Accessed on 24/02/2025
10. US Food and Drug Administration. FDA warns against using Magellan Diagnostics LeadCare testing systems with blood obtained from a vein: FDA safety communication. https://www.fda.gov/medical-devices/tests-used-clinical-care/safety-issue-magellan-diagnostics-leadcare-testing-systems Accessed on 24/02/2025
11. Rosales-Rimache J, Chavez-Ruiz M, Inolopú-Cucche J, Rabanal-Sanchez J, Rueda-Torres L, Sanchez-Holguin G. Leadcare® II comparison with graphite furnace atomic absorption spectrophotometry for blood lead measurement in Peruvian highlands. Indian Journal of Clinical Biochemistry. 2023;38(3):324-330. DOI: 10.1007/s12291-022-01050-y
12. Nakata H, Nakayama SM, Yabe J, Muzandu K, Toyomaki H, Yohannes YB et al. Assessment of LeadCare® II analysis for testing of a wide range of blood lead levels in comparison with ICP–MS analysis. Chemosphere. 2021;271:129832 DOI: 10.1016/j.chemosphere.2021.129832
13. https://www.magellandx.com/leadcare-products/leadcare-ii/Accessed on 24/02/2025
14. Sobin C, Parisi N, Schaub T, de la Riva E. A Bland–Altman comparison of the Lead Care® System and inductively coupled plasma mass spectrometry for detecting low-level lead in child whole blood samples. Journal of Medical Toxicology. 2011; 7:24-32. DOI: 10.1007/s13181-010-0113-7
15. Thurtle N, Greig J, Cooney L, Amitai Y, Ariti C, Brown MJ et al. Description of 3,180 courses of chelation with dimercaptosuccinic acid in children≤ 5 y with severe lead poisoning in Zamfara, Northern Nigeria: a retrospective analysis of programme data. PLoS

medicine. 2014;11(10):e1001739. DOI: 10.1371/journal.pmed.1001739
16. Hettmansberger TL, Mycyk MB. Lead poisoning presents a difficult diagnosis. American Family Physician. 2002;66(10):1839. https://pubmed.ncbi.nlm.nih.gov/12469959/
17. Ericson B, Hu H, Nash E, Ferraro G, Sinitsky J, Taylor MP. Blood lead levels in low-income and middle-income countries: a systematic review. The Lancet Planetary Health. 2021;5(3):e145-153. DOI: 10.1016/S2542-5196(20)30278-3
18. Roy A, Bellinger D, Hu H, Schwartz J, Ettinger AS, Wright RO et al. Lead exposure and behavior among young children in Chennai, India. Environmental health perspectives. 2009;117(10):1607-1611. DOI: 10.1289/ehp.0900625
19. Pant V, Gautam K, Pyakurel D, Shrestha A, Pradhan S, Joshi N. Broadening the list of differential diagnosis for acute abdomen–a case report from Nepal. EJIFCC. 2020;31(4):347. https://pmc.ncbi.nlm.nih.gov/articles/PMC7745298/
20. Liu J, Li L, Wang Y, Yan C, Liu X. Impact of low blood lead concentrations on IQ and school performance in Chinese children. PloS one. 2013;8(5):e65230. https://doi.org/10.1371/journal.pone.0065230
21. Mackay AK, Taylor MP, Munksgaard NC, Hudson-Edwards KA, Burn-Nunes L. Identification of environmental lead sources and pathways in a mining and smelting town: Mount Isa, Australia. Environmental Pollution. 2013; 180:304-311. DOI: 10.1016/j.envpol.2013.05.007

Supplementary
Survey Questionnaire

1. Name of Country:

2. How frequently does your laboratory test for lead levels in patients?
a) Daily
b) Weekly
c) Monthly
d) Rarely/Never

3. What methodologies does your laboratory use for lead testing? (Select all that apply)
a) Flame atomic absorption Spectrometry
b) Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
c) Electro thermal atomic absorption Spectrometry
d) CLIA waived POCT device based on Anodic stripping voltametry

4. What is the most common source of lead exposure identified in your region?
a) Occupational exposure
b) Environmental contamination
c) Dietary sources including herbal remedies
d) Household items including toys

5. Which of the following sources have you used to learn about lead poisoning? (Select all that apply)
a) Academic journals
b) News articles
c) Social media
d) Workshops/Webinars
e) Government health resources
f) Community organizations

6. What challenges do you face in implementing lead toxicity testing in your practice or region?
a) Lack of resources (equipment, reagents)
b) Limited awareness among healthcare providers
c) Policy barriers
d) Non-compliance from patient

7. What policy changes are needed to improve lead screening and management in the Asia-Pacific?
a) More government support for testing
b) Stricter rules on lead exposure
c) Better training for healthcare workers
d) Support from international organizations