# **Childhood Lead Exposure Prevention:** Assessment of Blood Lead Surveillance Capacity

## Colombia

Vital Strategies

PURE EARTH

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# Acknowledgments

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**Contributors**

Jesica Rodriguez-Lopez, Vital Strategies

Daniela Alonso Molano, Pure Earth

Yi Lu, Vital Strategies

Dan Kass, Vital Strategies

Lizeth Olaya Zambrano, Pure Earth

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# Acronyms and Abbreviations

| | |
|---|---|
| **AAS** | Atomic Absorption Spectroscopy |
| **BLL** | Blood Lead Level |
| **ETAAS** | Electrothermal Atomic Absorption Spectroscopy |
| **FAAS** | Flame Atomic Absorption Spectroscopy |
| **ICP-MS** | Inductively Coupled Plasma Mass Spectroscopy |
| **ICP-OES** | Inductively Coupled Plasma Optical Emission Spectroscopy |
| **IHME** | Institute for Health Metrics and Evaluation |
| **IQ** | Intelligence Quotient |
| **LSP** | Public Health Laboratory |
| **MoE** | Ministry of Environmental and Sustainable Development |
| **MoH** | Ministry of Health and Social Protection |
| **NHI** | National Health Institute |
| **µg/dL** | Micrograms per Deciliter |
| **NGO** | Nongovernmental Organization |
| **PISA** | Comprehensive Environmental Health Policy |
| **SDEH** | Subdirection of Environmental Health |
| **SUISA** | The Unified Environmental Health Information System |
| **TSIP** | Toxic Sites Identification Program |
| **ULAB** | Used lead acid battery |
| **WHO** | World Health Organization |

# Executive Summary

Lead exposure is a significant public health concern in Colombia, with over a half million children estimated to have a blood lead level (BLL) above 5 micrograms per deciliter (µg/dL), a level that requires action according to WHO. Even low levels of lead exposure can decrease the IQ and exacerbate learning problems, developmental delays and behavioral disorders that can persist throughout a child's life. The long-term effects of lead exposure can have significant economic and social impacts on societies, perpetuating cycles of disadvantage and inequality. And lead absorbed early in life is stored in bone, leading to elevated risks of cardiovascular disease as people age. Children are exposed to lead through diverse sources in their daily lives, including unregulated industrial practices, lead paint used in households, and unsafe consumer products.

The Colombian Congress enacted Law 2041 in 2020, protecting people's right to develop physically and intellectually in a lead-free environment. It calls for monitoring blood lead levels among children to understand their exposure and provide timely treatment. To support implementation of this law, Pure Earth and Vital Strategies are exploring the capacity to establish childhood blood lead surveillance in Colombia under a new project titled "Strengthening Health Systems to Reduce Lead Exposure." The project aims to partner with the Colombian government to design and pilot surveillance efforts that help estimate the local burden of childhood lead exposure, identify common sources of lead exposure, and inform policy actions and interventions. To enable this effort, we conducted this capacity assessment of Colombia's existing infrastructure and resources to support a national blood lead surveillance system.

## Policy Landscape

Colombia has adopted various international initiatives and standards related to lead management, including the Basel Convention, Rotterdam Convention, and the Organization for Economic Co-operation and Development (OECD) recommendations on reducing lead exposure. The country has established national policies and standards to regulate lead use in consumer products such as gasoline, paint, cookware, and utensils. These initiatives and standards are implemented by various ministries including the Ministry of Environment and Sustainable Development (MoE), the Ministry of Health and Social Protection (MoH) and the Agricultural Institute. In 2020, Law 2041 laid out an important foundation for advancing blood lead surveillance in the country by highlighting the importance of monitoring lead exposure and providing timely treatment for children.

## Cross-Sector Coordination on Lead Management

We have identified numerous important agencies and initiatives that play a prominent role in managing lead exposure and should be engaged and informed during the process of planning blood lead surveillance in the country. The National Intersectoral Technical Commission for Environmental Health (CONASA) coordinates cross-sectoral efforts in developing and implementing environmental health policies and strategies such as the Comprehensive Environmental Health Policy (PISA). PISA highlights the need to monitor chronic lead exposure and the importance of a more comprehensive surveillance effort than the existing Public Health Surveillance System (SIVIGILA), which only captures severe cases of lead intoxication.

The MoH is also a key partner in establishing blood lead surveillance. This includes the Direction of Promotion and Prevention (P&P), particularly the Subdirection of Environmental Health, which is responsible for providing technical support for identifying and managing detected lead intoxication cases. The Direction of Epidemiology and Demography (DED) should be consulted in designing and incorporating blood lead measurements into existing surveillance systems, since they direct the Ministry's activities in the Public Health Surveillance System.

The National Health Institute (NHI) can be a critical partner when piloting the blood lead surveillance effort to demonstrate its feasibility and importance. NHI has worked closely with MoH to design and implement public health surveillance programs. Key NHI partners include the Environmental and Occupational Health Research Group, which monitors lead exposure among workers; the Environmental Health Group, which monitors lead in environmental samples; the Direction of Surveillance and Risk Analysis, which generates protocols and guidelines for public health surveillance, and the National Health Observatory, which produces data and evidence that inform policy decisions.

In addition to the health sector, it would be important to engage and inform other departments, such as the Ministry of Environment and Sustainable Development, which regulates lead pollution and its environmental impacts. Informing the MoE and other departments about identified sources of lead exposure from surveillance can help enforce existing regulations and develop effective policies. Moreover, it would be important to leverage knowledge and support from local researchers who have previously studied lead exposure in Colombian populations. These include the National University of Colombia, the University of Los Andes, the University of El Valle, and the Universities of Cartagena, Cordoba, and Atlántico.

## Public Health Surveillance Capacity

Previous studies on blood lead levels (BLL) in Colombian children are limited, especially in those under age 5, and no study has been conducted at the national level. The average BLL measured in the general child population varied across regions, with 2.57 µg/dL in Bogota, 4.74 µg/dL in Cartagena and 3.5 µg/dL among school-age children living in other five cities. However, studies that measured children living in areas with known lead pollution found much higher average BLLs, including in children with BLL over 50 µg/dL. The understanding of lead exposure sources at home for Colombian children is also limited, as previous studies have mainly focused on industrial sources like smelting and battery recycling. While elevated levels of lead have been found in paint, ceramic and metal cookware in markets, no study has assessed their contribution to children's BLLs.

At the national level, acute lead intoxication is monitored and reported by health professionals through SIVIGILA. However, the number of intoxications due to lead is not well known, as information on the suspected source is not reported in the data portal. SIVIGILA also does not capture routine lead exposure among children, which leads to tremendous health and societal impacts. Also, there is likely a significant underreporting of acute childhood lead poisoning cases because few children are tested for exposure. In 2017 the epidemiology profile of intoxications in Colombia from 2008-2015 showed that only 1% (or 2,054) of the total intoxication cases were attributed to metals exposure, and of them only 111 were reported on children under 5. In 2022 there were a total of 51 cases of metal intoxications; of them just 21 were reported in children 0-5 years old; and in 2024, by April 2, only 5,668 intoxications from all causes were reported in the country through SIVIGILA, including 958 cases among children under 5.

At the local level, since 2017, the District Secretary of Health in Bogota has implemented a sentinel surveillance system to identify children at risk of lead and mercury exposure. This program screened and tested blood lead levels among children with an elevated risk of lead exposure. They conducted awareness campaigns about this issue during surveillance and shared their findings in annual reports on environmental health to raise awareness.

A number of health and nutrition surveys are regularly conducted in Colombia, but none of them currently assess a child's lead exposure. The upcoming National Survey of Nutritional Situation in Colombia (ENSIN) and National Survey of Demography and Health (ENDS) in 2024 could be promising opportunities to incorporate BLL tests and lead exposure assessment questionnaires and initiate a sustainable government-led surveillance effort.

## Laboratory Capacity for Testing BLLs

Overall, Colombia has limited laboratory capacity for BLL testing, especially within government-affiliated laboratories. We identified just two public health laboratories, both in Bogota, which conduct BLL tests. Public laboratories in Cundinamarca and Valle del Cauca can measure heavy metals in environmental samples but not in blood samples. We also identified eight non-governmental laboratories, including three university laboratories and five private laboratories, capable of analyzing lead in blood. Overall, most laboratories use atomic absorption spectroscopy (AAS), and the testing cost is generally high (ranging from USD$9 to $44 per sample). Based on limited current laboratory capacity, it would be important to expand the testing capacity in the identified national laboratory and explore agreements with university or private laboratories to support the government's effort to monitor blood lead levels regionally or nationally.

The limited laboratory capacity could be supplemented using a portable analyzer for BLL that has been validated and used in other Latin American countries. Portable analyzers have been used in five projects to measure blood lead levels in children and adults with satisfying results when compared with laboratory measurements. Despite some limitations of the portable analyzer, it can be a good addition for screening of children, and using it requires minimal training.

In conclusion, we find that a pilot effort to understand lead exposure among Colombian children at the national level will be a critical first step to initiate sustainable blood lead surveillance in Colombia. This will provide scientific evidence to characterize lead exposure in the population, raise awareness of this issue in key stakeholders, identify the major sources of lead exposure, and demonstrate the feasibility and value of increasing capacity to monitor lead exposure and of targeting efforts to reduce lead sources and future exposure. This should be done in collaboration with government partners that play a key role in lead poisoning prevention, including CONASA, MoH, MoE and NIH.

# Introduction

Lead is a heavy metal that is widely dispersed in the environment, causing concern due to its detrimental effects on human health and the ecosystem throughout history. It is found naturally in the earth's crust and has been used in various industrial and commercial applications. Lead is a toxic metal that can have serious health impacts and affects many systems in the body. Young children are particularly susceptible to lead poisoning because they absorb far more lead from their environments than adults do and because their central nervous systems are still developing.(1) Children can be exposed to lead through inhaling or ingesting lead particles, lead-contaminated dust or soil, drinking water, paint chips and consumer products at home.(1) This may decrease IQ and exacerbate learning problems, developmental delays and behavioral disorders that can persist throughout a child's life.(2–4) The long-term effects of lead exposure can have significant economic and social impacts on societies.(5,6) Exposed children may face educational and employment difficulties, which can perpetuate cycles of disadvantage and inequality.

Lead poisoning contributes to tremendous disease and economic burden in Colombia. The Institute for Health Metrics and Evaluation (IHME) estimated that more than half a million children have a BLL above 5 µg/dL, a level that requires action.(7) A study that analyzed blood samples of school-age children from five communities in Northern Colombia found that over 15% had a BLL above 5 µg/dL.(8) The burden on health care systems and the loss of human potential also affect the economic development of nations. A study in 2023 estimated that in Colombia, lead exposure in children is responsible for an average 4.1 IQ-point loss per child and results in an economic loss of 5 million U.S. dollars, equivalent to 1.5% of the country's gross domestic product.(5)

Children are exposed to lead in their daily lives through diverse sources. Unregulated industrial practices can release high levels of lead into the air and soil. The Toxic Sites Identification Program has documented nearly 30 lead-contaminated sites around the country (Figure 1). Previous research in Colombia has found high blood lead levels among children living in industrial zones and near lead smelters or used lead acid battery (ULAB) recycling sites.(9–11) It is important to note that ULAB recycling is a highly underreported and under-monitored occupation in the country, given the nature of this job. Lead paint used in households, especially formulations violating the regulation published in 2020, is also an important source of lead exposure at home. One study that tested lead in solvent-based paint found more than half of the samples contained levels of lead exceeding the standard.(12) Children may also be exposed through using unsafe consumer products adulterated or contaminated with lead. A recent project conducted by Pure Earth detected high concentrations of lead when screening paint, and ceramic and metal cookware or dinnerware purchased from markets in Colombia.(13) A study in Bogota detected lead in panela (a popular sweetener made of sugar cane blocks) and breast milk.(14,15) Children may also be exposed to lead dust brought home by parents working in industries involving lead, such as battery recycling plants and mechanical workshops.(11) In Colombia, despite the notable reduction of lead exposure in industrial processes, the decrease in the import and export of leaded products, and the banning of lead in gasoline in 1991, lead remains a challenge in the field of national public health due to its persistent use in informal labor activities and its significant health impacts.(16,17)

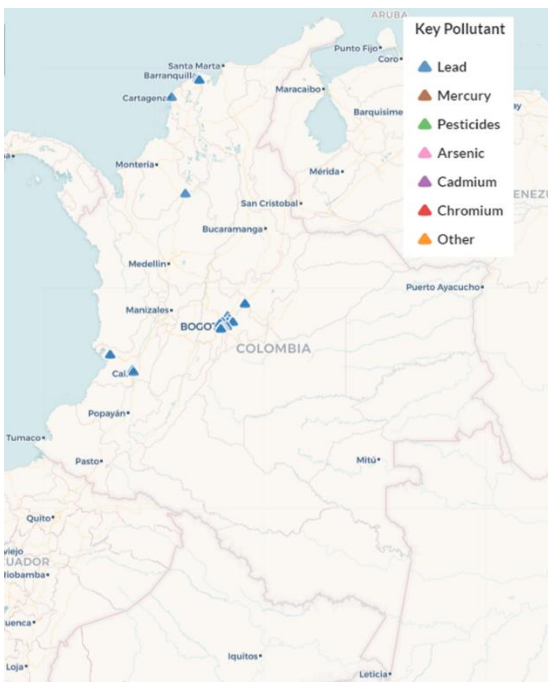


*Figure 1: Lead-contaminated sites in Colombia. Source: Toxic Sites Identification Program (TSIP). Accessed March 2024.*

While previous studies assessed lead exposure and sources among children in a specific area, no nationwide study or surveillance has been developed to understand the risk of lead exposure and its common sources at a population level for children in Colombia. In 2020 the Colombian Congress enacted Law 2041, which guarantees the right of people to develop physically and intellectually in a lead-free environment. This law established limits for the lead content in products marketed in the country, especially those used by children. It also calls for monitoring blood lead levels among children to understand their exposure and provide timely treatment.(18)

In line with Law 2041, Pure Earth and Vital Strategies are exploring the capacity to establish childhood blood lead surveillance in Colombia under a new project titled “Strengthening Health Systems to Reduce Lead Exposure”. We aim to work in partnership with the Colombian government to design and pilot surveillance efforts that help estimate the local burden of childhood lead exposure, identify common sources of lead exposure, and inform policy actions and interventions. As a first step, we conducted a capacity assessment of existing resources and infrastructure in Colombia to establish childhood blood lead surveillance and summarized our findings in this report.

# Policy Landscape

## Policy and Regulation Related to Lead

Colombia has agreed to comply with several important international initiatives and standards associated with lead management.

- Basel Convention: Colombia adopted the Convention in 1996 by Law 253.(19) In 2010, Colombia hosted the 10th Meeting of the Conference of the Parties (COP) and adopted the Cartagena Declaration. The Ministry of Environment and Sustainable Development is responsible for the implementation of this convention.
- Rotterdam Convention: Colombia adopted the Convention in 2007 by Law 1159.(20) The use of tetraethyl lead (CAS 78-00-2) and tetramethyl lead (CAS 75-74-1) is regulated under the Convention of Rotterdam. The Ministry of Environment and Sustainable Development, the Ministry of Health and Social Protection, and the Agricultural Institute are responsible for monitoring and implementing the convention.
- Organization for Economic Co-operation and Development (OECD) recommendation: In 2020, Colombia officially became an OECD member. Through decision C(96)42, Declaration on Risk Reduction for Lead (1996), the OECD urges member countries to reduce the risk of exposure to lead through different routes, strengthen monitoring systems of lead levels in the environment and in vulnerable populations, promote environmentally sound recycling programs for lead and related products, and use knowledge to achieve better risk management.

Colombia also established national policies and standards to regulate lead use in consumer products. It started regulating the levels of lead in gasoline under Decree 948 of 1995. Law 1530 of 2002 further established that gasoline containing tetraethyl lead in quantities greater than those internationally specified may not be imported, produced, or distributed in the country, except as fuel for piston aircraft. Following this, the Ministry of the Environment and the Ministry of Mines and Energy established the quality specifications of the fuels that are imported, produced, distributed, and consumed in the country. In 2005, the Ministry of Health and the Ministry of Commerce jointly established the technical standard under Resolution 408 specifying permissible limits of lead released from ceramic and glass cookware and utensils that come in contact with food and drinks. In 2015, Colombia proposed Bill No. 148 to ensure children's right to a lead-free environment, regulating lead content in products. Chapter III focuses on paints, specifically Article 12, prohibiting the manufacturing and importation of architectural paints with lead content exceeding 50 ppm (dry basis or total nonvolatile content). The bill was modified in the Senate's Seventh Committee, which approved a lead content limit of 100 ppm in the definitive version. Published in March 2015, the bill, now law, was sent to the full Senate. The modified version emphasized the need to reduce lead levels to protect children's physical and intellectual development in homes and public spaces. In 2018, a policy brief was prepared by the Ministry of Health, titled Paints from the Home with Lead: A Silent Risk for Our Children, which presented scientific findings that supported developing regulations for lead in paint.

In 2020, Law 2041 was enacted, with the main objective being to "guarantee the physical, intellectual development and general health of people, especially that of boys and girls residing in the national territory [of Colombia], in a lead-free environment by establishing general guidelines to prevent contamination, poisoning and diseases derived from exposure to this metal." The scope included all public and private entities involved in importing, using, manufacturing, distributing, and selling products containing lead. The law established guidelines to prevent contamination, intoxication and diseases resulting from lead exposure. It defined key terms and set the permissive limit for lead in blood as 5 µg/dL, with a focus on protecting children and pregnant women. The law also mandated establishing a national system to monitor blood lead levels among children and other vulnerable populations to determine baseline exposure for the country and track progress.(21)

The legislation also required the government, through the National Intersectoral Technical Commission for Environmental Health (CONASA), to formulate policies and strategies for lead reduction and elimination. In accordance with Law 2041 of 2020, the Ministry of Health and Social Protection (MoH) issued Resolution 1440 of 2021 to establish the technical regulations for glass, ceramic and ceramic hob items that come in contact with food, whether they are manufactured in or imported to Colombia, to minimize health and safety concerns related to lead and cadmium. Similarly, Resolution 734 of 2022 provided technical regulations on lead in toys and their accessories that are manufactured in or imported to Colombia. To track compliance with the law and MoH regulations, it would be important to quantify the lead levels in a child's home environment and consumer products and evaluate their contribution to the child's blood lead levels.

# Cross-Sector Coordination on Lead Management

## National Intersectoral Technical Commission for Environmental Health (CONASA)

Recognizing the intersectoral nature of environmental health, the ministry engages in policy development and implements strategies outlined in documents like CONPES 3550 (2008), Decree 2972 (2010), the Decennial Public Health Plan and the Comprehensive Environmental Health Policy (PISA, in its Spanish acronym). Internal approaches aim to integrate environmental health within various sectors to mitigate the impact of environmental factors on regional and national disease burdens by considering conflicts, production dynamics, habitat initiatives, legal mandates, and climate change threats.

As a result, the National Intersectoral Technical Commission for Environmental Health (CONASA) was established to articulate and harmonize sectoral norms, promote information dissemination, and recommend cooperation mechanisms across sectors. The committee responds to the impacts of environmental deterioration and inappropriate chemical management on air and water quality, as it affects public health. CONASA is tasked with coordinating and guiding the PISA's design, formulation, and implementation. The commission includes representatives from various ministries. CONASA is currently chaired by the Ministry of Environment Sustainable Development, but this will change to the Ministry of Social Protection or its delegates during the next session. CONASA can establish thematic working groups for environmental health issues. These groups, guided by the Technical Secretariat, will focus on implementing the action plan outlined in document CONPES 3550 of 2008. The Department of National Planning, specifically the Subdirection of Sustainable Environmental Development or its equivalent, serves as the Technical Secretariat.

Law 2041 of 2020 gave CONASA the leading role in developing policies and implementing this law. The offices addressed in this law are the Ministers of Health and Social Protection;

Commerce, Industry and Tourism; Environment, Housing and Territorial Development; the Direction of the Administrative Department of Science, Technology and Innovation (COLCIENCIAS); the Direction of the National Institute for Food and Drug Surveillance (INVIMA), and the Direction of the National Institute of Health. The law stated that, through CONASA, the government "will formulate the guidelines and policies for the development of strategies, actions, campaigns, educational activities, dissemination guidelines, training, sensitization and awareness aimed at the reduction and elimination of lead, as well as preventions related to the contents of this law." Within five years of the enactment of this law, CONASA "will formulate the public policy for the verification of reduction of exposure to maximum levels of lead in children, girls and adolescents in the national territory; for this purpose, the principle of fiscal sustainability will be followed." Based on these requirements, CONASA is in a great position to design the monitoring or surveillance system that determines the baseline lead exposure in children at the national level. Findings from this system will provide solid ground for developing guidelines and policies aimed at reducing childhood lead exposure and help track progress.

It is important to note that CONASA can only make recommendations to be carried forward by different ministries that will generate and enforce policies. To inform such policies, CONASA relies on the available information. Another limitation identified is the lack of steady input, since CONASA has only met once since 2022.

## The Comprehensive Environmental Health Policy (PISA)

The Comprehensive Environmental Health Policy — PISA is a management policy that covers all environmental health issues, designed within the framework of CONASA. The general objective is to strengthen comprehensive and intersectoral management in environmental health, which contributes to improving environmental quality and health status. Its specific objectives are:

1. Improve knowledge management in environmental health for decision-making purposes.
2. Strengthen governability and governance of comprehensive environmental health management.
3. Implement strategies to reduce morbidity and mortality associated with environmental factors and their costs.

In the current version of PISA, the section on exposure to chemical substances, including lead, highlights the need to identify and monitor chronic exposure and help prioritize affected populations. This statement supports the need for a more comprehensive surveillance effort, as the current SIVIGILA system only captures acute but not chronic intoxication.(22)

### The Unified Environmental Health Information System (SUISA)

SUISA is a unified environmental health information system defined as a knowledge management system that collects and captures the information produced by governmental sectors and analyzes social and environmental determinants and their effects on the health of the population. This supports intersectoral decision-making and provides intersectoral management and risk knowledge and communication. It is organized under environmental health themes such as water, air, climate, chemicals, and road safety, among others.

In line with the competencies and the functions, CONASA entities will implement SUISA. As part of knowledge management in PISA, they will characterize information sources prioritized for environmental health, integrating them into SUISA. Additionally, they will ensure the timely supply and update of information from each institution, following identified needs for environmental health management under PISA.

The report on the burden of environmental health by the NHI in 2018 emphasized the gap in information and research related to lead exposure and its effects in the country, resulting in a lack of information for decision-making.(23) Hence, CONASA sees the need to include lead exposure data in the SUISA system. SUISA can be an excellent platform from which to combine lead exposure data (e.g., average BLL by region) collected during surveillance with environmental and population risk factors to inform policy decisions.

## Health Sector

The Ministry of Health and Social Protection (MoH) coordinates and implements national policy and social services on health and social security.(24) Within the Ministry of Health, the Direction of Promotion and Prevention (P&P) will be a critical partner for establishing blood lead surveillance, as it is responsible for proposing policies and projects for health promotion, disease prevention, and control and communication of diseases. P&P oversees the Ministry's implementation and evaluation of health programs, proposes norms and policies for environmental health, coordinates with environmental authorities and monitors their implementation.

Within P&P, the Subdirection of Environmental Health (SDEH) serves roles most relevant to monitoring and reducing lead exposure. It is responsible for crafting policies and projects related to the prevention, detection, control, and intervention of risks from chemicals and hazardous substances affecting health. In the event of lead intoxication, SDEH provides technical assistance as needed, guides contingency plan methodology with monitoring, enforces policies ensuring effective management for chemical poisoning cases, and heads prevention measures through intersectoral inspection, surveillance, and control, including sector-specific special measures and necessary interventions identified from event analyses. Depending on the magnitude and impact, these events may be presented to the institutional epidemiological surveillance committee and the strategic committee, led by SDEH, to inform policymakers on policy actions involving other sectors (e.g., environment, labor, and defense). SDEH also actively participates in the formulation, implementation, and evaluation of the PISA and the development of the PISA Management Model and SUISA. SDEH guides studies and research in environmental health and implements health promotion and prevention strategies in coordination with national, territorial, or private partners. SDEH would be an ideal partner to initiate and coordinate the design and implementation of blood lead surveillance efforts across relevant parties within MoH and translate these findings into effective interventions and policies.

Another key partner to engage within the Ministry of Health for establishing blood lead surveillance is the Direction of Epidemiology and Demography. This Direction is responsible for proposing, developing, and executing public health research activities as well as directing and coordinating the Ministry's activities in the public health surveillance system. Due to their key role in public health surveillance and relevant expertise, this Direction should be consulted during the design and incorporation of blood lead measurements into existing public health surveillance systems.

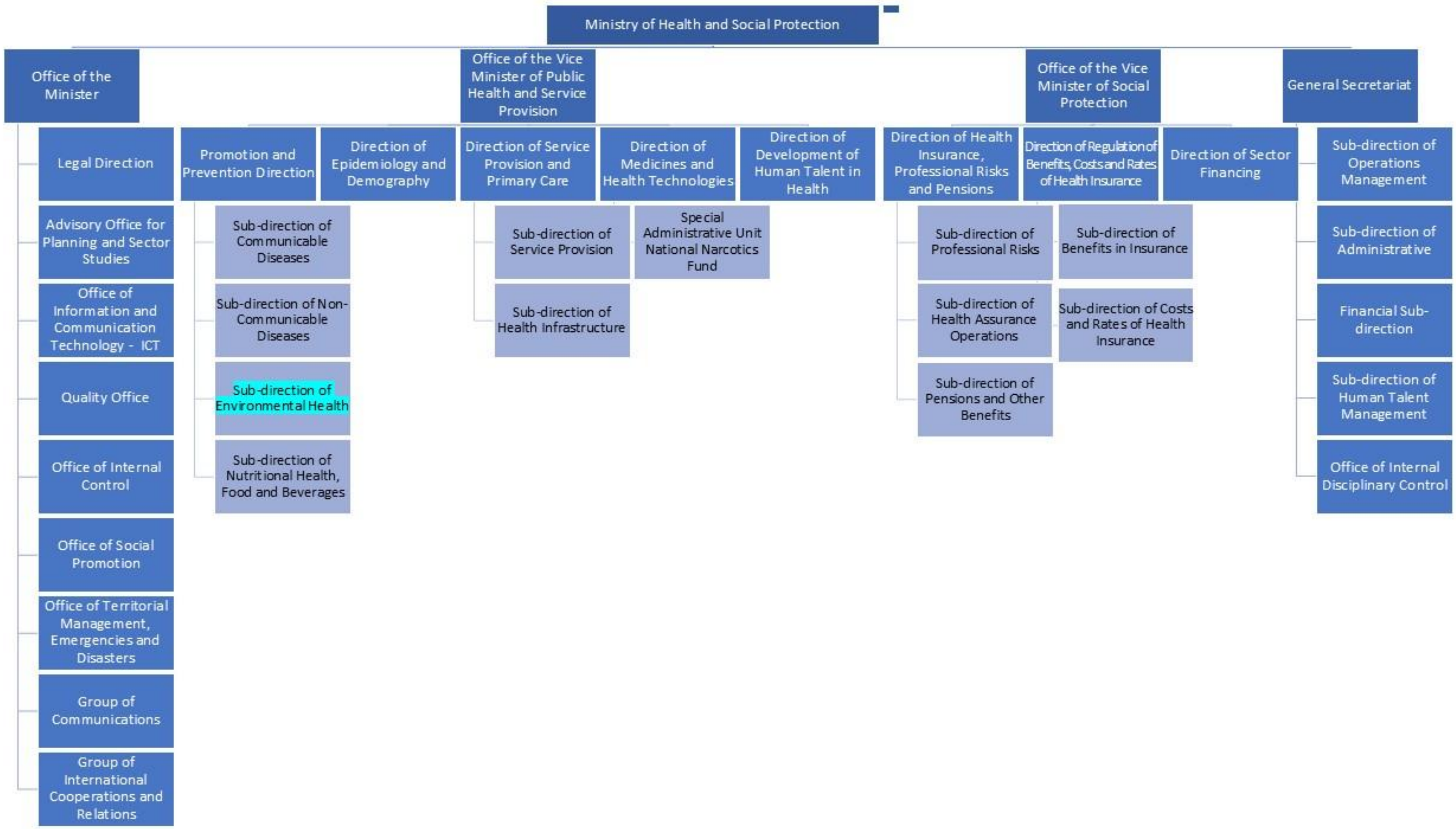


*Figure 2: Ministry of Health and Social Protection organigram*

The National Health Institute (NHI) is a national entity linking the science, technology and innovation sector with the health and social protection sector. It coordinates the country's public health surveillance system and generates evidence and knowledge to support the formulation, adjustment, and assessment of health policies. It also trains personnel for the surveillance and reporting of events of interest in public health surveillance. The NHI has played a vital role in implementing public health surveillance and research programs in coordination with and under the supervision of MoH. Therefore, they can be an important implementation partner for establishing blood lead surveillance.(25)

There are various directions within the NHI that can be important to engage with in designing blood lead surveillance programs. The Environmental and Occupational Health Research Group under the Direction of Public Health Research assessed blood lead levels among workers with occupational exposure to lead in 2015.(26) They are also part of the Network for Knowledge Management, Development and Innovation in Safety and Health at Work, a consortium of 22 institutions, including universities, decision-making entities, technical education institutes and a civil society organization, that focus on enhancing health and work conditions through knowledge sharing and innovation.

The Chemistry and Toxicology Group within the Direction of Public Health Networks runs a reference laboratory capable of monitoring lead in environmental and blood samples. The group conducts diagnostic activities on water and biological samples, leads external performance evaluations and offers technical assistance to departmental public health laboratories. It will be important to collaborate with this group to support testing for surveillance and expand public and private laboratories' capacity in lead testing.

The Direction of Surveillance and Risk Analysis in Public Health generates protocols for public health surveillance, national guidelines for risk surveillance and analysis in public health, scientific documents evaluating food safety risks, and pesticide toxicology. They also utilize epidemiological data, transfer knowledge through public health research and technical assistance to local entities and conduct field epidemiology training and capacity-building activities.

Last but not least, important for the development of blood lead surveillance is the National Health Observatory, which produces evidence for policy decisions, integrates key epidemiological data, identifies gaps in knowledge for research, and promotes knowledge networks among health actors in the country.

## Environmental Sector

The Ministry of Environment and Sustainable Development serves an important role in regulating lead pollution and its environmental impacts.(27) The Ministry, in collaboration with the President, formulates national environmental and renewable natural resource policy to safeguard the right to a healthy environment. It directs the National Environmental System (SINA), oversees international environmental policy, and coordinates the prevention of ecological risks. Additionally, this Ministry formulates economic studies, fiscal analyses, and environmental tariffs, and oversees regional autonomous corporations for environmental issues.

Within the Ministry, the Direction of Environmental and Urban Sectoral Affairs leads efforts to monitor and implement the Basel Convention. Colombia ratified the Basel Convention in 1996 through Law 253, upheld by Constitutional Court Ruling C-977/96. Hosting the 10th Conference of the Parties (COP) in 2010, Colombia adopted the unprecedented Cartagena Declaration and showcased the country’s commitment to safe chemical and hazardous waste management using a new strategic framework. In the ninth Open-Ended Working Group meeting in 2014, Colombia led efforts to assess progress in implementing the Cartagena Declaration. The country stressed the importance of reducing waste at its source and minimizing cross-border movements.

This Ministry has also played a key role in facilitating the regulation of lead in paint. To meet OECD’s requirements for potential members, Colombia crafted a Revised Position document for the Chemicals Committee that outlined the country’s chemical management framework, progress, and harmonization needs. During this process, the ministry developed the policy brief on lead in paint in 2018, a work that was supported by Vital Strategies and became the preamble for Law 2041 of 2020.

The Ministry of Environment and Sustainable Development is part of CONASA, and, under Law 2041 of 2020, the Ministry will reinforce the environmental control and monitoring activities of all industrial establishments that process, recover or recycle lead and ensure they comply with current environmental regulations. Furthermore, based on the guidelines issued by the Ministry of Environment and Sustainable Development, the environmental authorities promote conducting studies or research projects in conjunction with the private sector, aimed at implementing cleaner technologies in the recycling industry of elements that contain a concentration of lead in levels higher than those established in the regulations. Given this, the Ministry of Environment and Sustainable Development should be informed of the BLL surveillance work so that this can be used to evaluate the enforcement of current regulations and inform the development of policies targeting other important sources of lead exposure.

## Local Government

At the local level, the Bogota Health Secretary played a key role in developing and implementing the surveillance program to monitor lead and mercury exposure among children living in Bogota since 2017. The city health department has implemented the program in two areas of the city and plans to expand it to another area in 2024.

- Surveillance sites:
    - Hospitals where children were diagnosed with anemia and/or neurological delay and suspected lead poisoning
    - Schools located in areas with high risk of exposure
    - City quadrants with a high risk of exposure, defined as having a high density of car shops or metal-mechanic industries
- Inclusion criteria: children with a diagnosis of low school performance or a delay in neuro, growth, or language development
- Lab-based venous blood analysis accompanied by questionnaires to understand exposure sources/history and neurodevelopment assessment.

## Nongovernmental Entities

Through the literature review, we have identified a list of researchers who have conducted studies evaluating lead exposure and its health effects among children in Colombia. These researchers should be consulted and informed about current efforts of building blood lead surveillance with the government and be involved during the design, interpretation and policy formation based on their expertise.

The National University of Colombia has researchers in the Public Health and Toxicology departments who study lead exposure and its health effects and influence on public policy. They worked with the National Institute of Health, the Ministry of Health and Social Protection, and the Ministry of Environment Development to create a national program for monitoring mercury exposure. They are equipped with a toxicology laboratory that has blood lead testing capability. The University of Los Andes has research experience in analyzing the genotoxic effects of lead exposure in occupationally exposed populations. Researchers from the University of El Valle assessed lead exposure and its effects on children and pregnant women living near the industrial areas of Cali, while researchers from the universities of Cartagena, Cordoba and Atlántico assessed lead exposure among children living in the northeastern coastal region.

The following NGOs also worked on reducing lead exposure in Colombia:

- Colnodo Association, a Colombian partner of the International Pollutants Elimination Network (IPEN): Conducted two studies on lead content in paint (2016 and 2022) and advocated for regulating lead in paint and for lead-free paint production practices.
- Lead Exposure Elimination Project (LEEP): even though there is no documentation on their work or actions in the country, we learned from their team that they are recruiting a member to coordinate the project in Colombia on supporting the enforcement of lead paint regulations.

Table 1 lists potential stakeholders to engage in building a blood lead surveillance program in Colombia.

## Table 1: Potential stakeholders

| Type | Agency | Role/Division |
|---|---|---|
| National Government | Ministry of Health and Social Protection (MoH) | Vice Minister of Public Health |
| | | Laboratory Coordinator |
| | | Environmental Health Subdirection |
| | | Epidemiology Subdirection |
| | National Health Institute (NHI) | General Director |
| | | Technical Director of the Direction of Public Health Research |
| | | Environmental and Labor Health Group — Coordinator |
| | | Toxicology Director |
| | Ministry of Environment and Sustainable Development (MoE) | Environmental Consultant |
| | | Heavy Metal Technician |
| | | Heavy Metal Coordinator |
| | Ministry of Labor | Environmental Division |
| | | Security and Work Health |
| Academic Institutions | Universidad de los Andes | Director of the Legal and Public Health Clinic |
| | Universidad de Cartagena | Toxicology Department |
| | Universidad de Cordoba | Expert |
| | Universidad Nacional | Toxicology Department |
| | Universidad Nacional | Toxicology Department |
| | Universidad Nacional | Laboratory Coordinator |
| | Universidad de Antioquia | Laboratory Director |
| | Universidad de Cordoba | Expert |
| Local Government | Bogota Health Secretary | District Toxic Surveillance |
| | | Technical Chemist |
| | | Technician |
| | | Program Director |
| | Governorate of Cundinamarca | IVC Sanitarian Chemist/Surveillance Subdirection |
| | | Public Health Director |
| NGO | Pan American Health Organization (PAHO) | Advisor on Disease Prevention and Control |
| | | Chemical Safety Advisor |
| | Colnodo Association | Environmental Exposure of Lead Researcher |
| | ICONTEC —National Validation and Verification Board for Products and Processes | Heavy Metals Direction |

# Public Health Surveillance Capacity

## Previous Studies that Tested BLLs Among Colombian Children

Previous studies evaluating BLL in Colombian children have been limited, particularly among children younger than five. Very few studies used a representative sample, and none were representative at the national level. A few studies that recruited children randomly from the area or from schools provided some insights on baseline lead exposure locally. A study in Bogota estimated the median BLL of children under 5 as 2.57 µg/dL.(28) Olivero-Verbel et al. evaluated school-age children from eight neighborhoods in Cartagena and found an average BLL of 4.74 ug/dL.(29) Alvarez-Ortega assessed BLL among school-age children in five municipalities and found an average BLL of 3.5 ug/dL.(8) A study in Cali found that the mean BLL of school-age children living in the unexposed control area was 3.0 ±1.2 µg/dL.(10) More studies focused on exposed children living in areas with a known source of lead pollution (e.g., smelting, battery recycling) found BLL ranging from 1.7 to 54 µg/dL.(9–11,30–32) A summary of the previous studies assessing BLL in children in Colombia is presented in Table 2.

The understanding of sources of lead exposure at home is quite limited for Colombian children. Previous studies primarily focused on industrial sources such as smelting, battery recycling and fishing with lead-based weights. According to a new report by Pure Earth, high levels of lead exceeding regulatory standards have been found in paint, ceramic and metal cooking or dinnerware sampled from markets in Colombia.(13) A recent study tested 48 solvent-based paint samples in Colombia and found almost half of the samples contained levels of lead exceeding regulatory limits.(12) However, no study has assessed the association between these emerging sources of lead exposure at home and blood lead levels among children to understand their contribution.

Table 2: Summary of previous studies that tested BLL among children in Colombia.

| Authors | Publication Year | Study Year | Location: City, Department | Study Population/ Sample Size/ Sampling Setting | Mean BLL± SD, µg/dL; Prevalence of Elevated BLL, % | Suspected Source | Analytical Method |
|---|---|---|---|---|---|---|---|
| J Olivero-Verbel, et al. | 2006 | 2006 | Cartagena, Bolivar | Children 5-9 years old/189/Schools | 5.49 ± 0.23;<br>4.74 (1.0–21.0);<br>BLL ≥ 5 µg/dL: 42%;<br>BLL ≥ 10 µg/dL: 7.4% | Lead fishing net sinker, metal melting | GFAAS |
| CA Hurtado, M Guitierrez, J Echeverry | 2008 | 2004-2005 | Soacha, Cundinamarca, and Bogota | Children 5 months to 12 years old/32 / Home-based | 54 ± 21;<br>60.0 (32.5–70.0);<br>BLL ≥ 5 µg/dL: 100% | Battery recycling | GFAAS |
| PA Filigrana, F Méndez | 2012 | | Cali, Valle del Cauca | Children 6-14 years old/350 /Schools | **Exposed**:<br>4.7 ±1.6;<br>BLL ≥ 5 µg/dL: 44.2%<br>**Unexposed**:<br>3.0 ±1.2 µg/dL;<br>BLL ≥ 5 µg/dL: 8.2% | Industrial zone manufacturing steel, batteries, and metals | GFAAS |
| SD Osorio-García, et al | 2014 | 2012-2013 | Bogota | All ages/401/Home-based | **All:**<br>8.62 ±10.04;<br>BLL ≥ 10 µg/dL: 2.5%<br>**0-5 years old**:<br>2.57 (1.31–18.65);<br>**6-16 years old**:<br>7.92 (2.85-17.31);<br>**0-16 years old:**<br>BLL ≥ 10 µg/dL: 40% | Living in the southeast side of the city | GFAAS |
| AP Vergara Garcia | 2014 | 2013 | Malambo, Atlantico | All ages/59/Schools | **≤15 years old:**<br>25.58 ± 7.62<br>**>15 years old:**<br>17.15 ± 8.45 | Water contaminated by lead-melting industry | GFAAS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pure Earth | 2018 | 2017 | Malambo, Atlantico | All ages/181/Community-based | **Children (<18 years old):**<br>19.53±15.10;<br>15.7 (3.4-65.0);<br>**Adults:**<br>15.17±18.04;<br>7.6 (3.4-65.0); | Soil contaminated by lead-melting industry | LeadCare II |
| Pure Earth | 2018 | 2017 | Palmira, Valle del Cauca | All ages/168/Community-based | **Children (<18 years old):**<br>16.26±10.58;<br>15.0 (3.3-65.0)<br>**Adults:**<br>14.56±11.67;<br>10.8 (3.6-65.0) | Air and soil contaminated by lead melting industry | LeadCare II |
| N Alvarez-Ortega, et al. | 2017 | 2014 | Cartagena, Bolivar | Children 5-16 years old/118 /Home-based | 1.7±0.3;<br>1.3 (0.05-34.05); | Garbage disposal and heavy traffic; metal melting | GFAAS |
| N Alvarez-Ortega, et al. | 2019 | 2015 | Cartagena, Bolívar; Tasajera and Santa Marta, Magdalena; and Valledupar and La Paz, César | Children 5-19 years old/554/Schools | 3.5 ± 0.2;<br>1.9 (0.1-50.1);<br>BLL ≥ 5 µg/dL: 15.3% | Lead fishing net sinker, metal melting | GFAAS |
| L Carranza-Lopez, et al. | 2020 | 2015 | Cartagena, Bolivar | Children 5-16 years old/198 /Schools | 3.6 ± 0.3;<br>1.9 (1.2–3.1) | Lead fishing net sinker, metal melting, polluted soil, lead-based toys fabricated from backyard | GFAAS |

## Public Health Surveillance System (SIVIGILA)

SIVIGILA currently monitors a range of diseases, including infectious diseases (e.g., smallpox, acute respiratory infections, STDs) and noncommunicable diseases. Acute lead poisoning is classified as an event of interest to public health monitored and reported by health professionals to the SIVIGILA system. There is an overall reporting guide for all intoxications caused by chemical substances, but not one specific to lead. The guide advises that when an intoxication event is identified by *primary data generating units* (e.g., health care providers), it should be reported by filling and submitting Form 365. This form captures the type of chemical causing the intoxication, the location, time and means of exposure, and whether the case is confirmed clinically with a confirmed source of exposure. When there is suspicion of intoxication but no evidence of exposure, laboratory tests should be used to confirm the presence of the chemical in the body. The SIVIGILA guidelines ask for laboratory testing of whole blood using the GFAAS method for suspicious cases. If the local (district or department) Public Health Laboratory or the Primary Health Care Institution does not have this testing capacity, they should seek support from the national network of laboratories.

When the event is confirmed by clinical symptoms, report of exposure by a relative of the patient, a positive response to the administration of an antidote, evidence of use of the chemical in the place of intoxication, or laboratory analysis, the case is classified as *confirmed* by epidemiologic nexus. For cases of intoxication in children under 5, the case should be flagged in the surveillance system and reported immediately in SIVIGILA, and the surveillance protocol should be activated. The protocol for surveillance of lead intoxication in children entails integrated attention to the child, testing blood for BLL, treating the intoxication, and sending the report to the municipal health authorities to initiate the field investigation in the ensuing 24 hours. If the municipality does not have the means to conduct the field investigation, district and department level health authorities are called in to support.

While SIVIGILA requires reporting of acute lead poisoning cases, there is likely a significant underreporting of childhood lead poisoning cases. In 2017 the epidemiological profile of intoxications in Colombia 2008-2015 showed that among the 209,823 cases reported, only 1% (or 2,054) were attributed to metal exposure, with 111 reported for children under 5.(33) It was unclear how many cases were due to lead exposure, since there was no further breakdown of causes within the metals category. According to microdata from 2022 available in the SIVIGILA dashboard, 51 intoxications were due to metal exposure, of which 21 were reported for children under 5. In a meeting with an occupational insurance company, we learned that fewer than 15 cases of occupational lead exposure have been recorded since 2015. Given the confidentiality of the data, we could not verify this number using the publicly accessible SIVIGILA data.

Furthermore, the system only captures lead poisoning cases with extremely high blood lead levels and the most obvious and severe clinical symptoms. In our previous conversation with the Epidemiology Direction of the Ministry of Health, officials stated that this platform is designed for capturing acute events and will not capture children with moderately elevated lead exposure in the long-term that significantly affects their health and brain development.

## Bogota's Public Health Surveillance Program for Lead and Mercury Exposure

In Bogota, the District Secretary of Health established a sentinel surveillance system for lead exposure in two sectors of the southern part of the city in 2017. Public health officials identify children with possible environmental exposure to lead and mercury by surveilling educational institutions, searching for cases house-by-house in high-risk exposure areas (Exposure Quadrant Strategy), and deploying two neighborhood-based Sentinels Units. BLLs of identified children are determined using venous blood samples and the GFAAS method at the Public Health Laboratory of the District Secretary of Health. As part of the surveillance program, public health authorities also raise awareness and conduct training for health workers and those potentially exposed to mercury and lead.

In 2022, a total of 621 children were tested for exposure to lead and mercury. Of these, 337 (54.3%) were identified through educational institutions, 266 (42.8%) through the Exposure Quadrant Strategy and 18 (2.9%) through the Sentinel Units. The surveillance conducted in the Sentinel Units found just one case with high BLL (≥ 5 µg/dL). This child's potential environmental exposure included living with a smoker, putting toys, paint, and pencils in his/her mouth, living in an area where heavy traffic circulates, and having a father and uncle working at auto shops. The results for other surveillance areas were not accessible when this report was written.

## Existing National Health Survey Involving Children

There are some national surveys or cohorts that assess the health and nutrition status of children using a nationally representative sample of Colombian children. Incorporating blood lead tests and lead exposure assessment questionnaires into these routine national surveys can also be great opportunities for initiating sustainable government-led surveillance for lead exposure among children. Table 3 below summarizes the characteristics of existing national surveys.

Recent cycles of national surveys in Colombia were delayed due to conflicts with other public health priorities such as the COVID-19 pandemic, even though the survey methodologies had already been planned and approved. Both the National Survey of the Nutritional Situation in Colombia (ENSIN) and the National Survey of Demography and Health (ENDS) are likely to be implemented in 2024. ENDS provides the earliest opportunity for integration of BLL surveillance, as it samples children from the age group of interest, and a former version of the methodology of ENDS indicated that it may include biomarkers for lead and mercury exposure in children under 5 for the next cycle. Once confirmed, it will be a great opportunity to partner with the Ministry of Health to incorporate lead exposure assessment in the next cycle.

Table 3: National Surveys on Children's Health

| Survey | Head agency | Implementing agency | Sample | Target Child Population | Frequency of Survey (Year of Last Cycle) | Information Collected Relevant to Children's Health | Blood/Physical Tests |
|---|---|---|---|---|---|---|---|
| National Survey of Demography and Health (ENDS in Spanish, DHS in English) | Ministry of Health and Social Protection (MoH) | Profamilia, Colombian Institute of Family Welfare (ICBF), MoH, NHI and USAID | Nationally representative | 13-18 years old | Every 5 years (2015) | General health condition; SES; sexual health | None |
| National Survey of the Health and Nutritional Situation in Colombia (ENSIN) | Ministry of Health and Social Protection (MoH) | Colombian Institute of Family Welfare (ICBF), MoH, Administrative Department for Social Prosperity, the NHI and the Pan American Health Organization (PAHO/WHO) | Nationally representative (295 municipalities) | Aged under 5; 5-12; 12-17 years old | Every 5 years (2015) | Anthropometric measurements; nutrition, dietary intake; health condition; SES; health-seeking behavior | Yes, anthropometric measurements (e.g., height, weight, BMI) |
| Colombian Longitudinal Survey of Children (ELCA) | Los Andes University, Center for Studies on Economic Development | Los Andes University, Center for Studies on Economic Development | Nationally representative, excluding Amazonian region, and SES 5 and 6 (richest) | Aged under 5; 5-12; 12-17 years old | Every 3 years (2016) | Anthropometric measures, the Peabody Picture Vocabulary Test in Spanish | Yes, anthropometric measurements (e.g., height, weight, BMI) |
| Colombian National Survey on Public Health (ENS) | Ministry of Health and Social Protection (MoH) | National University of Colombia, Javeriana University, MoH | Nationally representative | Aged under 6; 6-12; 12-17 years old | Every 10 years (2007) | Felt morbidity, demand and utilization of medical and dental services, and vaccination | Only among adults |

# Laboratory Capacities

## Public Laboratories

Colombia has 32 departments and one District, and each has a departmental/district public health laboratory. Additionally, the country has one national reference laboratory at the National Health Institute. We have conducted desktop research and direct outreach to these laboratories to obtain information on their capacity to test lead in blood. By the time of this report, we had obtained this information from five of the 34 laboratories. Among these, two laboratories can currently conduct blood lead tests, and the remaining three reported varying levels of readiness for lead testing.

- ✓ The **National Reference Laboratory at the National Health Institute** analyzes BLL by using atomic absorption spectrometry and venous blood. It received national accreditation and has analyzed blood samples collected for research projects, public health surveillance and biomonitoring projects conducted by the National Institute of Health.
- ✓ **Bogota's District Public Health Laboratory** supported the blood lead surveillance effort and has technical and equipment capacity, based on a conversation we had with officials from the District Health Secretary. However, we do not have detailed information on their method and maximum testing capacity.
- \- **The public health laboratory of Cundinamarca** currently only measures heavy metals in environmental matrices and can process up to 200 samples per day. They reported having the technical capacity to process lead in blood samples if they were provided with the proper reagents for sample preparation.
- \- **The public health laboratory of Valle del Cauca** currently only measures heavy metals in environmental matrices. They expressed interest in processing heavy metals in other matrices such as blood, receiving support to increase their trained human resources and to get internationally accredited.
- ✗ The **departmental laboratory of Vichada** has a DMA-80 Evo for processing mercury samples. They reported that they have technical training to process lead in blood if provided with the equipment.

Overall, there is a lack of public information about the capacity of the National Network of Laboratories. In preparing this report we learned that department-level public health laboratories can only process samples taken in their area of coverage (e.g., in their departments), and it needs additional approval and coordination with the NHI national reference laboratory to process samples from other geographical areas.

## Private Laboratories

In addition, we identified eight nongovernment-affiliated laboratories, including three university laboratories and five private laboratories, that measure lead in blood. The reported testing cost ranged from US$9 to $44 but may vary depending on the number of samples to process. Among nongovernment laboratories, Colcan Laboratorio Clínico may be a suitable candidate for supporting large biomonitoring projects, as it reported a fairly low detection limit, can process a large number of samples per week at an affordable price, and can return the results within a week. The key characteristics of all identified laboratories are summarized in Table 4.

Overall, we observed extremely limited laboratory capacity for blood lead testing in Colombia, especially within government-affiliated laboratories. Only two government-affiliated laboratories reported past experience testing lead in blood, and they only supported small-scale BLL testing in response to emergencies/outbreaks or local screening efforts.

Table 4: Lab Capacity Assessment Summary

| Laboratory | Type | Municipality, Department | Metals Tested | Matrix | Analytical Method | Detection Limit | Minimal Sample Volume | Weekly Samples (Maximum Testing Capacity) | Turnaround Time | Unit Cost in 2024, COP (USD*) |
|---|---|---|---|---|---|---|---|---|---|---|
| Instituto Nacional de Salud (NHI) | PH Lab | Bogota D.C, Bogota D.C | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | GFAAS | 1,00 µg/dL | 5 mL | **Not stated** | Depends on number of samples | **Not stated** |
| LSP, Secretaria Seccional de Salud, Vichada | PH Lab | Puerto Carreño, Vichada | Nickel, Lead, Arsenic, Cadmium, Mercury | Water | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| LSP del Valle del Cauca | PH Lab | Cali, Valle Del Cauca | Nickel, Lead, Arsenic, Cadmium, Mercury | Water | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| LSP de Cundinamarca | PH Lab | Bogota D.C., Cundinamarca | Nickel, Lead, Arsenic, Cadmium, Mercury | Water | **NA** | **NA** | **NA** | **NA** | **NA** | **NA** |
| LSP, Secretaría Distrital de Salud de Bogota | PH Lab | Bogota D.C., Bogota D.C | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | GFAAS | **Not stated** | **Not stated** | **Not stated** | **Not stated** | **Not stated** |
| Universidad Nacional de Colombia | University | Bogota, D.C., Bogota, D.C. | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | GFAAS | 1,5 µg/dL, | 2-5 ml | 70 | 8-15 days | 180,000 (43.37) |
| Universidad de Córdoba | University | Montería, Córdoba | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | GFAAS | **Not stated** | **Not stated** | 250 | 8-15 days | 85,000 (20.48) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Universidad de Antioquia (LIME) | University | Medellín, Antioquia | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | FAAS | 2,5 µg/dL | 6 mL | 250 | 10 days | 175,800 (42.36) |
| Laboratorio Químico Clínico S.A.S. | Private | Barranquilla, Atlantico | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | GFAAS | 0,2 µg/dL | 4 mL | 250 | 48-72 hours | $83,300 (20.07) |
| Colcan Laboratorio Clínico | Private | National coverage, Multiple | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | GFAAS | 0,2 µg/dL | 4 mL | 1500 | 4 days | 35,000 (8.43) |
| Aoxlab S.A.S | Private | Medellín, Antioquia | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | ICP-OES | 0,015 µg/dL | **Not stated** | 600 | 3 days | 109,750 (26.45) |
| IDIME | Private | National coverage, Multiple | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | **Not stated** | **Not stated** | **Not stated** | **Not stated** | 12 days | 57,000 (13.73) |
| Sura | Private | National coverage, Multiple | Nickel, Lead, Arsenic, Cadmium, Mercury | Blood whole | ICP-MS | **Not stated** | 4 mL | 200 | 9 days | 45,956 (11.07) |
| Laboratorio Médico de Referencia | Private | Medellín, Antioquia | Nickel, Lead, Arsenic, Cadmium, Mercury | Urine | GFAAS | **NA** | **NA** | **NA** | **NA** | **NA** |
| (*) US $1 = COP $4,150 | | | | | | | | | | |

## Use of Portable Analyzers

There is one portable analyzer (i.e., LeadCare II) approved by the U.S. Food and Drug Administration (FDA). It has comparable accuracy with laboratory-based methods for BLL between 3.3 and 65 µg/dL.(34) It is comparatively cost-effective, easy to operate and can generate instant results onsite using a small amount of sample (50 µL) that requires no preservation or special handling.

We found four previous projects that used LeadCare in Colombia. One of the projects resulted in two publications. We summarized the characteristics of these publications in Table 5. Three of these studies were conducted with analytical support and ethical approval from the National Health Institute.

Table 5 Summary of Characteristics of Studies Using Portable Analyzer in Colombia

| Authors | Title | Publication Year | Study Year | Location: | Study Population | Sampling Type | Analytical Method |
|---|---|---|---|---|---|---|---|
| S Díaz-Criollo, et al. | Assessment of Lead Exposure of Colombian Informal Workers Who Recycle Batteries | 2021 | 2015 | Soacha | Lead-based-battery recyclers | Convenience sampling: 120 adults between 20 and 75 years old, 60 exposed and 60 unexposed | LeadCare II with validation using GFAAS |
| S Díaz-Criollo, et al. | Does Sulfuric Acid have a 'Protective' Effect on Battery Recyclers Exposed to Lead? | 2019 | | | | | |
| AD Hernandez-Gil, et al. | Genotoxic and Epigenetic Effects of Lead in Recycling Automotive Battery Workers | 2014 | 2013 | Bogota and Soacha | Artisanal battery factory workers | Convenience sampling: 30 exposed and 30 unexposed to occupational lead | LeadCare II |
| Pure Earth | 2017 Annual Report of Activities in Colombia | 2018 | 2017 | Malambo, Atlantico | Lead smelting contaminated area residents | Convenience sampling: 101 children and 80 adults | LeadCare II |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pure Earth | 2017 Annual Report of Activities in Colombia | 2018 | 2017 | Palmira, Valle del Cauca | Lead smelting contaminated area residents | Convenience sampling: 66 children and 102 adults | LeadCare II |

The study conducted in 2015 by the National Health Institute in coordination with the Cundinamarca Health Secretary aimed to identify exposure to lead and its association with epigenetic health outcomes in a community of lead-battery recycling workers in Soacha, Cundinamarca.(26) The researchers used LeadCare II to measure the BLL in capillary blood samples. LeadCare results were validated with a subset of venous samples using GFAAS by the National Reference Laboratory. During our conversation with the researchers of this study, they mentioned that the correlation between LeadCare II and the laboratory measurements was very high. It was also stated that LeadCare II is an acceptable tool for screening exposure to lead in the population. However, the high cost and short expiration date of testing kits prevented future use of this equipment. The LeadCare equipment was decommissioned after the 2015 study was completed. The same source data was used for another published study in 2019 that assessed lead exposure and sulfuric acid interaction.(17)

Another published study, resulting from a master's thesis conducted by a student at Los Andes University, used LeadCare II.(35) There, lead in capillary blood was assessed in 60 adults ranging from 20 to 69 years of age, 30 of them occupationally exposed to lead in battery factories, and 30 exposed non-occupationally. Lead in blood was assessed by a LeadCare II device at the National Health Institute, with no further details on the validation of the analytical method.

Pure Earth conducted two studies in 2017 in two highly lead-contaminated areas of Colombia, Malambo and Palmira, by using LeadCare II to assess lead in capillary blood samples.(32) The study in Malambo included 101 children and 80 adults, while the study in Palmira included 66 children and 102 adults. The published report did not mention the validation of BLL results using laboratory methods.

## Recommendations for Laboratory Capacity Building

Based on our assessment of current laboratory capacity in Colombia, we recommend the following approaches to expand and improve capacity to support government-led large-scale blood lead surveillance.

- Improve laboratory capacity at NHI by obtaining national accreditation on testing lead in blood, providing support for human resources (e.g., designated technicians), automating sample collection, upgrading analytical instruments, or improving established methods and accuracy through participation in the U.S. Centers for Disease Control and Prevention (CDC) proficiency program.
- Improve lab capabilities at Universidad Nacional de Colombia and explore collaborating with the government to support testing for a national lead screening/surveillance program.
- Explore agreements between the government and laboratories for a discounted cost for blood lead tests conducted at these laboratories to support large-scale surveillance or monitoring efforts (as has been considered in the recent cycle of national health surveys).
- Donate point-to-care analyzers to regional public health laboratories in the selected surveillance regions or regions identified with high BLL during the surveillance period to enable testing capacity for further screening of children locally. Additional funding for the purchase of testing kits and coordinating the purchase of testing kits with a local distributor are needed to prevent lack of use and quick expiration.

# Clinical Management Capacity

Poison Centers typically provide specialized clinical and public advice related to intoxication. Based on the 2023 WHO database on poison centers, we identified five centers in Colombia and one additional center in the National Network on Toxicology of Latin-American (RETOXLAC) directory (see Table 6). Framed in the National Level Toxicological Emergencies Response Strategy and other actions for the prevention and care of chemical and toxicological emergencies, there is a national telephone advice line ((+57-601) 2886012 / 018000-916012 / #116) that provides information on managing acute and chronic poisonings. The hotline provides technical advice for preventing toxicological events and information on available technical, diagnostic and treatment resources, among others.

For the clinical frontline, the Ministry of Health and Social Protection designed the Guide for the Management of Toxicological Emergencies in 2008, which was updated in 2016. This guide includes a chapter on lead poisoning detection, diagnosis and treatment in adults and children. Moreover, the NHI publishes and updates periodically the public health surveillance protocol for chemical substance intoxications. Both guiding documents are developed based on the WHO Guideline for Clinical Management of Exposure to Lead.

Table 6 Poison Centers in Colombia Identified from the 2023 WHO and RETOXLAC Database

| Name | City | Emergency Telephone | E-Mail | Website | Hours of Operation | Available to the Public | Source |
|---|---|---|---|---|---|---|---|
| Línea de Información y Asesoría Toxicológica Ministerio de Salud y Protección Social / Centro de Información de Seguridad de Productos Químicos CISPROQUIM Consejo Colombiano de Seguridad | Bogota, D.C. | (+57-601) 2886012/ 018000-916012 | cisproquim@ccs.org.co; lineatoxicologica@minsalud.gov.co | https://ccs.org.co/cisproquim/ https://www.minsalud.gov.co/salud/PServicios/Paginas/linea-nacional-de-toxicologia.aspx | 24 hours | Yes | WHO and RETOXLAC |
| Centro de Información de Sustancias Químicas, Emergencias y Medio Ambiente de ARL SURA - CISTEMA SURA | Bogota, D.C. | (+57-601) 4055911 option 1-1, 018000-511414 option 1-1 | cistema@arlsura.com.co acastro@sura.com.co | https://www.arlsura.com/index.php/biblioteca-cistema | 24 hours | Yes | WHO and RETOXLAC |
| Centro de Información y Atención en Toxicología de Cartagena y Región Caribe | Bolívar-Cartagena | (+57-317) 5010966 | specrued@cartagena.gov.co alvaro_cruzquintero@yahoo.es | https://www.dadiscartagena.gov.co/index.php/crue/ | 24 hours | Yes | WHO and RETOXLAC |
| Centro de Investigación, Información, Asesoría en Farmacología y Toxicología Clínica de Boyacá — CITOXBOY | Boyacá-Tunja | (+57-317) 5961452 | citoxboy@gmail.com | https://www.boyaca.gov.co/secretariasalud/crub-centro-regulador-de-urgencias/ | 24 hours | Yes | WHO and RETOXLAC |
| CIGITOX — Centro de Investigación, Gestión e Información Toxicológica de la Universidad Nacional de Colombia | Bogota, D.C. | (+57-601) 316 5000 ext. 15156 | cigitox012_fmbog@unal.edu.co | http://www.cigitox.unal.edu | 24 hours | Yes | RETOXLAC |

# Risk Communication Capacity

The Group for Surveillance and Control of Mental Health Events and Injuries of External Cause of the Directorate of Surveillance and Risk Analysis in Public Health disseminates through the institutional website the results of the surveillance of poisonings by chemical substances via:

- The weekly epidemiological bulletin (BES), where the information and preliminary analysis of the data obtained through SIVIGILA in the respective epidemiological week are made known, as are outbreak or alert situations reported by territorial entities.
- The Epidemiological Period Report, which presents a more detailed analysis of the preliminary information obtained through SIVIGILA for the respective period. It considers, among other variables, type and route of exposure, substance group and age groups for the event in general. Likewise, a particular analysis is conducted for each of the eight groups of substances.

The Ministry of Health developed preventive guidelines for informal economic activities that highly expose one to heavy metals, including lead, in 2016. In 2022, MoH published an informative communication material on the risks of lead exposure. There was also a communication campaign on preventing lead exposure from lead-paint contact.

The Ministry of Environment has a dedicated microsite on the proper handling of used lead-acid batteries, to prevent lead intoxication. Also, as part of the Colombian environmental information system, there is a microsite on lead, where information related to compliance with international agreements and national legislation as well as studies on lead in paint, can be found.

In 2019, the Bogota Office of Environmental Health of the Secretary of Health published and disseminated an infographic on lead educating the public about sources and actions they can take to reduce lead exposure. This office also published the chemical safety bulletins of 2019 and 2020, which highlighted actions that can be taken to avoid intoxication if exposed to chemicals, including lead. Information on intoxication cases in these bulletins is taken from the SIVIGILA system and analyzed for Bogota only.

# Conclusion and Recommendations

- Children in Colombia may be exposed to lead in their daily lives through various sources, such as soil contaminated by industrial activities involving lead, and consumer products containing lead (e.g., lead-based paint, and cooking or dinnerware).
- Previous studies and global models estimated that lead exposure among children in Colombia imposes a significant health and economic burden.
- Colombia has implemented various policies to protect children from lead exposure. Law 2041 of 2020 advanced this effort and called for action to monitor blood lead levels among children and understand lead exposure among children at the population level.
- There are several key government partners to engage when initiating blood lead surveillance in the country, including but not limited to, the National Intersectoral Technical Commission for Environmental Health (CONASA), Subdirection of Environmental Health (SDEH) of the Ministry of Health, and the National Health Institute.
- Previous studies in Colombia shed light on lead exposure among children locally and demonstrated the plausibility of monitoring blood lead levels among Colombian children. However, none of these studies can provide a national estimate or inform the prioritization of responses.
- There is an urgent need to measure lead exposure among children in Colombia using a nationally representative sample. This will be a critical first step to demonstrate the scope of this problem, raise awareness and engage government agencies in considering a long-term surveillance system and policy actions.
- The country should establish a system to monitor elevated lead exposure and acute lead intoxication among children. Colombia already has a passive surveillance system to monitor acute lead intoxication events but does not capture children suffering from chronic lead exposure that may significantly affect their health and development.
- There is a successful local surveillance model led by the District of Bogota that can be expanded elsewhere. They used a mixed (active and passive) surveillance system to screen lead exposure among children in some areas of the city.

- There are various laboratories identified with blood lead testing capacity. However, the testing capacity within public health laboratories is extremely limited and needs improvement.
- There have been a few uses of a portable blood lead analyzer, including by the National Health Institute, which showed good correlation with laboratory tests.
- Incorporating lead exposure assessment into future cycles of national health surveys such as ENDS can be a promising option for sustainable government-led blood lead surveillance.
- The National Institute of Health has a designated role and strong expertise in designing and implementing public health surveillance. A collaboration between them, Pure Earth and Vital Strategies on efforts to strengthen the health systems and reduce lead exposure would be a great opportunity to address the existing gaps.
- We foresee that the parties can work on establishing a surveillance system that monitors and characterizes childhood lead exposure, identifies major sources of lead, and increases knowledge and awareness of lead exposure and related health effects among health professionals and communities to boost early detection and treatment of exposed children.

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