

**Human toxicity from lead exposure***Toxicidad humana por exposición al plomo**Toxicidade humana por exposição ao chumbo***Luiz Carlos da Cruz Junior<sup>1\*</sup>**

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**Abstract**

This study aims to map the available scientific evidence on lead poisoning in the human body, considering its impacts on public health. A scoping review was conducted following the JBI methodological guidelines and the PRISMA-ScR recommendations. The search was conducted in SciELO, the MEDLINE database via PubMed, and the CAPES Periodicals Portal, encompassing studies published between 2018 and 2026, including materials made available in December 2025 and January 2026. The health descriptors are Lead Poisoning, Occupational Exposure, Public Health, Personal Protective Equipment, and Environmental Health. Studies addressing the toxicity resulting from lead exposure and prevention practices were included, focusing on awareness of the proper use of Personal Protective Equipment in work activities. The findings show shortcomings in the adoption and correct use of this equipment, as well as weaknesses in educational actions aimed at exposed workers. It is expected that the development of this protocol will present a consistent synthesis of evidence regarding adherence to personal protective equipment, highlighting that inadequate or insufficient use compromises worker protection, increases the risk of poisoning, and negatively influences health surveillance actions.

**Descriptors:** Lead Poisoning; Occupational Exposure; Public Health; Personal Protective Equipment; Environmental Health.

**Resumén**

El objetivo de este estudio es mapear la evidencia científica disponible sobre la intoxicación por plomo en el cuerpo humano, considerando sus impactos en la salud pública. Se realizó una revisión exploratoria siguiendo las directrices metodológicas de JBI y las recomendaciones PRISMA-ScR. La búsqueda se realizó en SciELO, la base de datos MEDLINE a través de PubMed y el Portal de Publicaciones Periódicas de CAPES, abarcando estudios publicados entre 2018 y 2026, incluyendo materiales disponibles en diciembre de 2025 y enero de 2026. Los descriptores de salud son intoxicación por plomo, exposición ocupacional, salud pública, equipo de protección personal y salud ambiental. Se incluyeron estudios que abordan la toxicidad resultante de la exposición al plomo y las prácticas de prevención, centrándose en la concientización sobre el uso adecuado del equipo de protección personal en las actividades laborales. Los hallazgos muestran deficiencias en la adopción y el uso correcto de este equipo, así como debilidades en las acciones educativas dirigidas a los trabajadores expuestos. Se espera que el desarrollo de este protocolo presente una síntesis coherente de la evidencia sobre el cumplimiento del uso de equipos de protección personal, destacando que un uso inadecuado o insuficiente compromete la protección de los trabajadores, aumenta el riesgo de intoxicación e influye negativamente en las acciones de vigilancia sanitaria.

**Descriptores:** Intoxicación por Plomo; Exposición Ocupacional; Salud Pública; Equipo de Protección Personal; Salud Ambiental.

**Resumo**

O objetivo deste estudo será mapear as evidências científicas disponíveis sobre a intoxicação por chumbo no organismo humano, considerando seus impactos na saúde pública. Realizou-se uma revisão de escopo seguindo as orientações metodológicas do JBI e as recomendações do PRISMA-ScR. A busca foi conduzida na SciELO, na base de dados MEDLINE via PubMed e no Portal de Periódicos da Capes, abrangendo estudos publicados entre 2018 e 2026, incluindo materiais disponibilizados nos meses de dezembro de 2025 e janeiro de 2026. Os descritores em saúde são Intoxicação por Chumbo, Exposição Ocupacional, Saúde Pública, Equipamento de Proteção Individual e Saúde Ambiental. Incluíram-se estudos que abordaram a toxicidade decorrente da exposição ao chumbo e práticas de prevenção, com foco na conscientização sobre o uso adequado de Equipamentos de Proteção Individual nas atividades laborais. Os achados mostram falhas na adoção e no uso correto desses equipamentos, bem como fragilidades nas ações educativas voltadas aos trabalhadores expostos. Espera-se que a construção deste protocolo apresente uma síntese consistente de evidências acerca da adesão aos equipamentos de proteção individual, destacando que o uso inadequado ou insuficiente compromete a proteção do trabalhador, aumenta o risco de intoxicações e influencia negativamente as ações de vigilância em saúde.

**Descritores:** Intoxicação por Chumbo; Exposição Ocupacional; Saúde Pública; Equipamento de Proteção Individual; Saúde Ambiental.



## Introduction

Lead is a heavy metal widely present in the environment, recognized as a highly toxic contaminant for humans and devoid of physiological function in the body. Exposure occurs mainly in environmental and occupational contexts, resulting in systemic effects, and is a public health and worker health problem. Lead exposure, traditionally linked to occupational and environmental contexts, is a significant determinant of high morbidity and mortality in the population. It is a clinical condition whose recognition is largely based on a diagnosis of exclusion, which is frequently made late, a circumstance that contributes to erroneous diagnostic interpretations and delays the institution of appropriate therapeutic measures<sup>1,2</sup>.

Exposure to lead is characterized by inducing systemic toxicity, affecting multiple systems of the human body. In the nervous system, it alters neurotransmission processes, leading to cognitive deficits, behavioral changes, and the occurrence of neuropathies. In the hematological system, it interferes with heme synthesis, resulting in anemia. In the renal system, it promotes progressive tubular damage, with subsequent reduction in renal function. In the cardiovascular system, it is associated with elevated blood pressure levels and an increased risk of cardiovascular events and diseases<sup>3</sup>.

Early identification of clinical signs and the adoption of appropriate diagnostic measures are important to minimize the impacts of lead poisoning. In this context, forensic medicine plays a significant role in the analysis of lead traces in biological tissues, assisting in determining the cause of death, investigating environmental crimes, and establishing legal accountability in cases of contamination. This study is justified by the need to expand knowledge about the risks associated with this contaminant, including its relevance in forensic investigations, and its contribution to practices that promote health, safety, and social justice<sup>4</sup>.

Lead poisoning generally results from the ingestion or inhalation of products containing this metal and may initially present with nonspecific symptoms, progressing to acute encephalopathy or irreversible organ damage. Diagnosis is based on blood lead levels (plumbemia), for which Brazilian occupational health legislation establishes, in NR-7, a Maximum Permissible Biological Index of around 60 µg/dL for exposed workers, although values from 40 µg/dL are already considered above the reference range in many laboratory services. Treatment includes cessation of exposure and, in selected situations, the use of chelating agents, such as succimer or disodium calcium edetate, alone or in combination with dimercaprol<sup>5,6</sup>.

Lead is a highly toxic environmental and occupational contaminant with bioaccumulation capacity and the potential to cause irreversible damage to human health, especially among exposed workers and socially vulnerable groups. Therefore, it is necessary to study how human toxicity resulting from lead exposure has been described in the scientific literature, regarding sources of exposure, at-risk populations, clinical manifestations, prevention strategies, diagnosis and treatment, and how these aspects are recorded in the professional practice of

healthcare teams. The hypothesis is that the findings will reveal gaps in the guidance for improving surveillance, care practices, and public policies aimed at reducing the impacts of lead on human health.

## Methodology

### Study Design

This is a scoping review protocol, a structured review method that maps concepts and findings related to the topic of interest, drawing on key data sources and employing a knowledge synthesis approach<sup>7,8</sup>.

### Protocol and Registration

Prepared according to the methodological recommendations of the Joanna Briggs Institute (JBI) and reported according to the PRISMA-ScR extension<sup>9,10</sup>, whose objective will be to map the use of standardized terminologies in the practice of health teams to describe human toxicity resulting from lead exposure and the available evidence on human toxicity resulting from lead exposure, considering different exposure contexts and their main health outcomes, the review protocol is registered on the Open Science Framework (OSF) platform under the identifier xc973, available at: <https://osf.io/xc973>.

Introducing the protocol, a search was conducted for previously published narrative review articles on the topic, aiming to map, in the scientific literature, the use of standardized terminology in the practice of healthcare teams to describe human toxicity resulting from lead exposure. The protocol will follow the methodological guidelines of the Joanna Briggs Institute and the PRISMA-ScR recommendations for scoping reviews<sup>7</sup> to guarantee transparency, reproducibility, and rigor in the search, selection, and analysis stages, the databases consulted for this introductory study were the Scientific Electronic Library Online (SciELO), the MEDLINE database via PubMed, and the CAPES Periodicals Portal, encompassing studies published from 2018 to 2026, as well as publications from December 2025 to January 2026. The descriptors used will be Lead Poisoning, Occupational Exposure, Public Health, Personal Protective Equipment, and Environmental Health.

### Research Question

Lead is recognized as a highly toxic environmental and occupational contaminant, with bioaccumulation capacity and the potential to cause irreversible damage to human health, especially among exposed workers and socially vulnerable groups. In this context, this study seeks to answer the following guiding question: "How has human toxicity resulting from lead exposure been presented in the scientific literature, considering the sources of exposure, the populations at risk, the clinical manifestations, the prevention strategies, the diagnosis and treatment, as well as how these aspects are recorded in the professional practice of healthcare teams?"

### Population

Studies, research, articles, and other scientific publications that address individuals exposed to lead will be



considered, including workers from different productive sectors, populations residing in contaminated areas, and socially vulnerable groups, of any age and gender.

### Concept

Studies addressing lead poisoning in the human body will be included, considering its mechanisms of action, acute and chronic effects, clinical manifestations, and repercussions for public health. This research will seek to explore the main theoretical and empirical foundations on the subject, examine the extent, scope, and nature of the available evidence, and synthesize the data to highlight existing gaps in scientific knowledge. It also aims to identify aspects related to prevention, diagnosis, treatment, and health surveillance practices focused on lead exposure and poisoning.

### Context

This review will consider environmental, occupational, and public health contexts in which lead exposure is discussed, including workplaces with chemical risks, communities impacted by industrial, mining, or waste sources, as well as health services responsible for the diagnosis, monitoring, and surveillance of poisoning cases. All studies addressing these contexts, in conjunction with the concept of lead toxicity in the human body, will be included to form the body of evidence analyzed.

### Eligibility Criteria

Studies addressing human toxicity from lead exposure in different population groups and care settings, considering clinical, occupational, and environmental aspects, will be included. The extracted data will be presented in a narrative summary, organized into tables that synthesize the main methodological characteristics

extracted from studies from the period 2018 to 2026. Exclusion criterion: studies dealing with other types of poisoning not involving lead will be excluded.

### Search Strategy

In the PubMed database, the search strategy will be structured as follows: “(“Lead Poisoning”[Mesh]) OR (“Lead Toxicity”[Title/ Abstract]) OR (“Plumbism”[Title/ Abstract]) OR (“Saturnism”[Title/ Abstract]) OR (“Lead Exposure”[Title/ Abstract])) AND (“Humans” [Mesh]) AND (“2018/01/01” [PDAT]: “2026/01/31”[PDAT]))”. In the SciELO database, the strategy adopted will be: “(“Lead Poisoning”) OR (“Lead Toxicity”) OR (“Saturnism”) OR (“Lead Exposure”)) AND (cluster\_year:(“2018” OR “2019” OR “2020” OR “2021” OR “2022” OR “2023” OR “2024” OR “2025” OR “2026”))”. In the Capes Periodicals Portal, the search will be performed with the following combination: “(“lead poisoning” OR “lead toxicity” OR “plumbism” OR “saturnism” OR “lead exposure”) AND (“humans”))”.

### Study selection

The evidence selection process will occur in two phases, with an initial screening based on titles and abstracts, followed by a full reading of potentially relevant texts by two reviewers, independently, with a third reviewer resolving any disagreements.

The data will be extracted using a standardized form, developed based on JBI recommendations, including information on study characteristics, population, exposure context, terms used to describe toxicity, and classification systems or scales used. The synthesis will be presented descriptively and thematically, through tables and narratives to highlight the variety, frequency, and gaps in the use of standardized terminologies related to human lead toxicity in the practice of healthcare teams.

Chart 1. Data extraction. São Paulo, SP, Brazil, 2025

Source/ database	Authors	Year	Country	Language	Study type and design	Exposed population/ group	Context and source of lead exposure	Study objective	Main results	Conclusions and gaps

### Data Extraction

Data extraction will be performed using a standardized form, based on JBI recommendations for scoping reviews. From each included study, information will be collected such as: identification (author, year of publication, country), study design, population characteristics (age range, sex, occupational group or exposed community), context and source of lead exposure (environmental, occupational, accidental, other), toxicity-related outcomes (clinical manifestations, laboratory findings, exposure and effect biomarkers, acute and chronic outcomes), prevention strategies and use of personal protective equipment, health surveillance actions, as well as the authors' main conclusions. The extraction form may be iteratively refined throughout the process if new relevant variables related to human toxicity from lead exposure are identified.

### Data Analysis and Presentation

The analysis of the data in this scoping review will be conducted using a qualitative approach, employing thematic analysis to organize and synthesize the information extracted from the selected studies. This method will allow the identification of recurring patterns, convergences, and divergences in the literature, as well as knowledge gaps that may guide future investigations. The findings will be grouped into thematic categories constructed from an in-depth reading of the articles, considering the following guiding axes: contexts and sources of lead exposure, affected populations and vulnerabilities, clinical manifestations and mechanisms of toxicity, prevention strategies and use of protective equipment, diagnostic approaches and exposure biomarkers, therapeutic interventions and case management, health surveillance and notification, and



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 professional records and terminologies used by health teams  
 in describing lead toxicity.

for future research, and identifying how human toxicity from  
 lead exposure is being described in the practices and records  
 of healthcare teams, supporting surveillance actions,  
 improving the quality of care, formulating public policies,  
 and enhancing nursing and health terminology in electronic  
 record systems.

### Expected Results

The expected outcome is the mapping of scientific  
 publications on lead poisoning and its outcomes in different  
 exposure contexts, highlighting knowledge gaps and needs

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