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LEAD CONTAMINATION IN FOOD: BIOACCUMULATION, MAXIMUM LEVELS, AND HUMAN HEALTH EFFECTS

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ABSTRACT

This review brings information on the toxic metal lead (Pb) and its bioaccumulative effects and impacts on human health, as well as a compilation of the main foods investigated in studies and legal limits. We searched 10 databases for studies published in the last 14 years. We used 35 studies that analyzed Pb in samples of food of plant (n=28) and animal (n=8) origin, and that analyzed 60 types of food. As for the maximum levels, those determined by four legislations were compiled. Pb toxicity mechanisms lead to changes in biological processes, which may occur as a result of indirect production of reactive oxygen species. The maximum levels of Pb in food, determined by legislation, contribute to the existence of a parameter that limits its occurrence, since the main route of exposure is food consumption, requiring greater monitoring of the levels of this contaminant and its effects on public health.

KEYWORDS: Lead. Metals. Toxicity. Maximum Levels.

CONTAMINAÇÃO POR CHUMBO EM ALIMENTOS: BIOACUMULAÇÃO, LIMITES MÁXIMOS E EFEITOS NA SAÚDE HUMANA

RESUMO

Essa revisão traz um levantamento sobre o metal tóxico chumbo (Pb) e seus efeitos bioacumulativos e impactos na saúde humana, além de um compilado dos principais alimentos investigados em estudos e dos limites legais. Buscou-se, em 10 bases de dados, estudos publicados nos últimos 14 anos. Foram utilizados 35 estudos que analisaram Pb em amostras de alimentos de origem vegetal (n=28) e animal (n=8), e que analisaram 60 tipos de alimentos. Quanto aos limites máximos, compilou-se aqueles determinados por quatro legislações. Os mecanismos de toxicidade do Pb levam a mudanças nos processos biológicos podendo ocorrer pela produção indireta de espécies reativas de oxigênio. Os limites máximos toleráveis de Pb em alimentos, determinados por legislações, contribuem para que exista um parâmetro que limite sua ocorrência, visto que a principal via de exposição é a alimentação, demandando um maior monitoramento dos níveis desse contaminante e de seus efeitos na saúde pública.

PALAVRAS-CHAVE: Chumbo. Metais. Toxicidade. Limites máximos toleráveis.

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1 INTRODUCTION

Metals are groups of elements that can be found everywhere, as they are part of the composition of the Earth's crust, soil, water bodies, and atmosphere (Hartwig & Jahnke, 2017). Toxic metals are a group of substances that present long-term toxicity in the body (Stančić et al., 2016). Unlike organic contaminants, metals are not biodegradable (Magna et al., 2013), as they accumulate (Hartwig & Jahnke, 2017) and are concentrated since they have retention capacity in the most superficial layers of the Earth's crust, which is most active part of the soil, and being easily transmitted to plants (Magna et al., 2013). Besides that, metals can advance between the levels of the food chain because they have trophic biomagnification capacity (Amirah et al., 2013).

As each toxic metal presents a distinct mechanism of toxicity, identification and treatment are major challenges (Zheng et al., 2020), but, in general, the main mechanism involved is the generation of reactive oxygen species (ROS) and, consequently, the induction of oxidative stress (Wacewicz-Muczyńska et al., 2021).

High levels of metals in the soil can lead to greater absorption by plants, which contributes to making the chemical contamination of food a major concern for the environment and human health. Some foods have the ability to absorb the metals of contaminated soils, mainly through their roots, and to aggregate them to leaves, fruits and flowers (Magna et al., 2013). The increase in industrial activity leads to the contamination of hydric resources by toxic metals (Canelhas et al., 2023) and reducing their concentrations has been the focus of researchers (Paz et al., 2018). Besides that, this contamination also occurs due to the contamination of wastewater and groundwater, causing problems in agricultural production (Ametepey et al., 2018).

The metal lead (Pb) was classified as a hazardous product and of relevant health concern due to its wide distribution in the environment and its toxicity (World Health Organization, 2019). As a highly harmful metal, Pb has toxic effects on the human body (G. Wang et al., 2019).

This literature review brings a compilation of information obtained through the scientific literature on the bioaccumulative effects and consequences of Pb on human health through food.

2 METHODS

Bibliographic searches were conducted in order to evaluate the mechanism of toxicity of lead and its bioaccumulative effects on the human body, the impacts of contamination by this contaminant on public health, in addition to compiling the main foods investigated for Pb contamination and maximum limits tolerated in food legislation. We conducted searches for studies published in the last 14 years (2012-2025). The first search included the years 2012 to 2023, and an update search included the years 2024 and 2025. The databases used were: MEDLINE, Scopus, ScienceDirect, FSTA (Food Science and Technology Abstracts), Web of Science, CAB Direct, Gale - Academic OneFile, AGRIS (Agricultural Sciences and Technology), Wiley Online Library, and Google Scholar.

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The following descriptors were used on database searches: 'food', 'human food' in association with 'lead', 'heavy metal', 'toxic metal', 'trace element', 'non-essential element', 'multi-element', 'ecotoxic' and combined with 'toxicity mechanism', 'bioaccumulation', 'biological accumulation', 'human organism', 'public health', and 'human health'. The search strategies followed each database's recommendations. The research was refined considering the years of publication (last 14 years), as well as the type of publication, where only primary research articles were used. There was no language restriction.

Searches were also carried out on official governmental websites on current national and international legislation that established maximum levels (ML) for contaminants in food, including Pb. The foods included in the legislation were listed and categorized by food groups that had characteristics in common.

3 RESULTS AND DISCUSSION

This review's results and discussion will be addressed regarding the mechanism of toxicity of lead and the bioaccumulative effects on the human body, the main foods investigated for lead contamination, the maximum tolerated limits of lead in foods in accordance with current legislation recovered, in addition to the impacts of lead contamination on public health.

The data in Table 1 come from 35 studies that were included from the searches, of which the data were divided into products of plant origin and products of animal origin, which were organized by countries of origin in alphabetical order. The results presented in Table 2 come from the legislation recovered during the research. In Figure 1 a graphical summary of the mechanisms of toxicity of lead and its bioaccumulative effects is presented.

3.1 Mechanism of toxicity of lead and bioaccumulative effects on the human body

Pb has aroused the concern of researchers due to its high bioaccumulative capacity and toxicity. It is a substance of public health importance according to the Agency for Toxic Substances and Disease Records, since low concentrations can trigger adverse clinical and subclinical conditions in humans (Curcio et al., 2022).

Pb enters the human body mainly through the airways and gastrointestinal tract (Kasperczyk et al., 2012). When ingested through contaminated food, it is distributed mainly in three ways: in the blood (99% in plasma, 1% in red blood cells), in bone tissue, and in soft tissues (liver, kidneys, brain, lungs, spleen), remaining there for up to 30 days, 25 years, and 40 days, respectively (World Health Organization, 2022). Although not very prevalent in plasma, its high bioavailability stands out, consequently determining its toxicity (Junior, 2014).

Due to the strong absorption by the gastrointestinal tract, diet becomes a relevant preventive route of bioaccumulation. In fact, nutritionally poor diets can increase Pb enteral absorption (Pedroso, 2017).

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Chronic Pb bioaccumulation in the human body can cause anemia (Kasperczyk et al., 2012), nephropathy (Wilk et al., 2017), bone fragility in older adults (García-Esquinas et al., 2015), neurotoxicity, damage to the nervous system (H. Wang et al., 2021), Alzheimer's disease (Huat et al., 2019a), hypertension (Wildemann et al., 2016), immunotoxicity (World Health Organization, 2022) and toxicity to reproductive organs (World Health Organization, 2022; Zheng et al., 2020).

The acute Pb toxicity leads to the appearance of nonspecific symptoms such as gastrointestinal changes, irritability, insomnia, headache, reduced libido, and impairment of several organs, however, this type of toxicity is quite unusual (Rocha et al., 2018).

The Pb toxicity mechanism (Figure 1) causes significant changes in biological processes and may occur due to the production of ROS (reactive oxygen species) (Wildemann et al., 2016), leading to the destruction and antioxidant imbalance of enzymes and cells (Fu & Xi, 2020), causing oxidative stress (Wacewicz-Muczyńska et al., 2021).

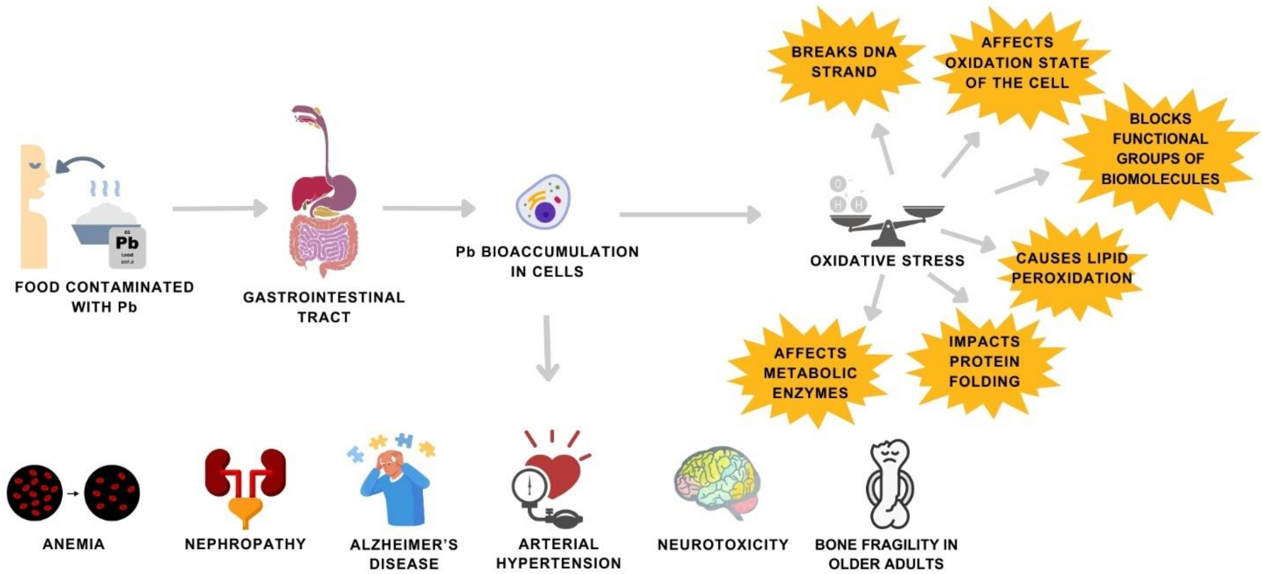

Figure 1. Pb toxicity mechanisms and bioaccumulative effects. Source: created by the authors.

It is also worth mentioning that ROS have their generation mechanism in mitochondria, cytoplasm, or cell membrane, and their cellular target are macromolecules and DNA (C. Silva et al., 2019). The increase in ROS leads to oxidative stress due to the antioxidant imbalance in the biological system (Hellwing, 2022).

Pb participates in the inhibition and even destruction of the main antioxidant cellular enzymes, especially those with a thiol group (--SH), being the main example glutathione peroxidase (GPx) (Ali et al., 2019) and enzyme delta-aminolevulinic acid dehydratase (δ-ALAD) (Junior, 2014). This metal binds to the –SH group of GPx and ALAD and inhibits the activity of these metalloenzymes (do Nascimento et al., 2014).

The hematopoietic system is affected by Pb accumulation because it acts restricting the synthesis of hemoglobin, through the inhibition of the enzymes ALAD, coproporphyrin oxidase, and ferrochelatase (Junior, 2014; Pedroso, 2017), also causing the reduction of the lifespan of circulating

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erythrocytes and increasing the fragility of cell membranes, which can cause anemia in humans (Gomes, 2020).

Even though chronic Pb bioaccumulation occurs primarily in bone tissue, its primary accumulation begins in the kidneys. Pb accumulation occurs in the proximal tubule of the kidneys after a period of chronic exposure, causing kidney damage, and may lead to nephropathy (Wilk et al., 2017).

The Pb mechanism of action in the body can contribute to the development of Alzheimer's disease because the action of this metal promotes the increase of the expression of amyloid protein precursors (APP) and β-secretase (BACE1), interrupting the correct functioning of the microglia, leading to an increase in the production of β-amyloid (Aβ), causing an increase in the formation of plaques (Huat et al., 2019b).

Children are more susceptible to the effects of exposure to toxic metals because they do not have cognitive, physical, or physiological maturity. They retain most of the Pb they absorb. While adults retain approximately 1%, children retain up to 50% (World Health Organization, 2022). When acutely or chronically exposed to toxic metals, even at low levels, disorders in the central nervous system are common, being manifested mainly through deficits in intelligence, attention and memory, deficiencies in functional, behavioral and psychological development (Nascimento et al., 2014).

3.2 Main foods investigated for lead contamination

Among the 35 studies retrieved from the databases, analyses of 60 different types of food were found (Table 1), out of which 80% were of vegetable origin (48 different foods). The most frequently investigated products in the 28 studies that analyzed Pb in foods of vegetable origin were: lettuce (in 9 studies), cabbage (n = 6), tomato (n = 5), potato (n = 4), parboiled rice (n = 4), carrot (n = 3), spinach (n = 3), parsley (n = 3). The most frequently investigated products of animal origin in 8 studies that analyzed Pb in this type of samples were: butter (n = 3), cow’s milk (n = 3), and white cheese (n = 2).

Table 1. Main foods investigated for Pb contamination

STUDY	COUNTRY	FOOD
PLANT ORIGIN FOOD		
(Godebo et al., 2024)	Belize, Bolivia, Brazil, Colombia, Congo, Ivory Coast, Costa Rica, Dominican Republic, Ecuador, Ghana, Guyana, India, Indonesia,	Chocolate

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	Madagascar, Mexico, Nicaragua, Papua New Guinea, Peru, Philippines, São Tomé and Príncipe, Sierra Leone, Tanzania, Trinidad, Uganda, Venezuela, Vietnam	
(Magna et al., 2013)	Brazil	Almonds
(Silvestre & Nomura, 2013)	Brazil	Rice
(Araújo et al., 2014)	Brazil	Lettuce
		Green bell pepper
		Tomato
(Villa et al., 2014)	Brazil	Chocolate
(Corguinha et al., 2015)	Brazil	Polished rice
		Parboiled rice
		Brown rice
(V. D. da Silva et al., 2022)	Brazil	Curly lettuce
		Cabbage
		Escarola
(Garcia, 2024)	Brazil	Yerba mate
(Nedzarek et al., 2013)	Bosnia, Herzegovina, Brazil, Lebanon, and Poland	Coffee
(Y. Chen et al., 2013)	China	Bok-choy
		Cabbage
		Lettuce
		Radish
		Garlic
		Pepper
		Eggplant
		Tomato
		Strawberry
		Celery
		Spinach
(Y. Chen et al., 2014)	China	Lettuce
		Cabbage
(Liu et al., 2016)	China	Italian lettuce
		Chinese cauliflower
(Vrček et al., 2014)	Croatia	Wheat flour
(Vitali Čepo et al., 2018)	Croatia	Red and white wine
(Hadayat et al., 2018)	United States	Tomato
		Lettuce
		Onion
		Carrot
		Potato
(Romero-Estévez et al., 2020)	Ecuador	Tomato
		Lettuce
(Cámara-Martos et al., 2021)	Spain	Green turnip
(Palisoc et al., 2018)	Philippines	Sweet potato
		Pumpkin
		Cabbage

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(Xavier et al., 2020)	India	Amaranth
		Eggplant
		Coriander
		Cauliflower
		Spinach
		French bean
		Fenugreek leaves
		Mint
		Cucumber
		Tomato
(Drava & Minganti, 2019)	Italy	White wine
(Elmi et al., 2019)	Kuwait	Lettuce
(Hisham et al., 2021)	Malaysia	Mustard
(Oladoyinbo et al., 2019)	Nigeria	Soups
		Cabbage
(Glodowska & Krawczyk, 2017)	Poland	Beet
		Carrot
		Parsley
		Onion
		Leek
		Parsley
		Parsley
		Potato
		Parboiled rice
		Brown rice
(Parreira, 2012)	Portugal	Tea
(Popović-Djordjević et al., 2022)	Republic of Serbia	Cabbage
		Kohlrabi
		Brussels sprouts
		Beet
		Carrot
		Potato
		Garlic
(Wijeyaratne & Kumari, 2021)	Sri Lanka	*Alternanthera sessilis*
(Karnpanit et al., 2019)	Thailand	Flowering water spinach
		Chinese mustard
		Chinese cabbage
		Thai water Spinach
		Lettuce
		Chives
		Chinese radish
		Cucumber
		Long beans
		Green beans
ANIMAL ORIGIN FOODS		
(Lazarus et al., 2021)	Croatia	Honey

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(Rodríguez-Bermúdez et al., 2018)	Spain	Cow's milk
(Cámara-Martos et al., 2021)	Spain	White cheese
		Butter
(Hasmi & Mallongi, 2016)	Gulf of Youtefa, Jayapura	Fish
(Qin et al., 2021)	England	Cow's milk
(Parinet et al., 2018)	France	Pork
(Battisti et al., 2024)	Italy	Bulk milk (cow's milk, sheep's milk)
		Butter
		Cheese (buffalo mozzarella, pecorino, and raclette type)
		Cream
		Curd
		Drinking milk (including all heat-treated ready-to-drink milk)
		Infant formula (powdered, liquid)
		Yogurt
(Seğmenoğlu & Baydan, 2021)	Turkey	Cow's milk
		White cheese
		Butter

In a systematic review and meta-analysis conducted in parallel by our research group (SOUSA et al., 2024) aiming to investigate if there were differences in Pb levels in organic (OLV) and conventional leafy vegetables (CLV), 24 studies were included and a significant difference (p=0.008) was observed in the metanalysis considering results in fresh weight (mean difference = 0.01 mg/kg), indicating an inferior concentration of Pb in OLV. The study demonstrates the challenges in synthesizing data on the Pb levels in different food samples, including their presentation. Due to those challenges, in the present review, we did not establish the goal of providing synthesis of the Pb levels in the samples analyzed in the studies listed in Table 1.

3.3 Compilation of the maximum levels of Pb in food legislation

The collegiate board resolution RDC No. 487/2021, through IN No. 88/2021 (*Brasil*, 2021), the National Standards of the People's Republic of China GB2762-2022 (China, 2023), the *Codex Alimentarius* (FAO/WHO, 2019), and the Regulation of the European Union Commission 2015/1005 (European Commission, 2015), establish the maximum levels (ML) of food contaminants, including Pb.

The ML of Pb in food determined by these four legislations, in mg/kg, are listed in Table 2, and organized by food group. Such legislations establish different ML, and they may be important for consumers' decision making.

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Table 2. Maximum levels of Pb in food legislation.

Food group (Food)	Legislation			
	Brazil (Brasil, 2021)	China (China, 2023)	*Codex Alimetarius* (FAO/WHO, 2019)	European Union (European Commission, 2015)
	Pb concentration (mg/kg)			
Sugars and sugary foods				
Sugars	0.10	0.5	*	*
Candies, caramels, and similar products, including chewing gum	0.10	*	*	*
Jams, jellies, marmalades, and other fruit- and vegetable-based sweets	0.20	0.40	0.40	*
Miscellaneous food				
Table olives	0.50	*	0.40	*
Nuts, including walnuts, pistachios, hazelnuts, macadamia nuts, and almonds	0.80	0.20	*	*
Tea, yerba mate, and other vegetables for infusion	0.60	5.0	*	*
Tomato concentrates	0.50	*	*	*
Edible ice	0.01	*	*	*
Young Rods and Petioles	0.20	0.10[#]	*	*
Pulses (dried seeds of legumes), except soybeans	0.20	0.20	*	0.10
Honey	0.30	0.50	*	0.10
Edible oils and fats of vegetable and/or animal origin (including margarine)	0.10	0.08	0.08	0.10
Salt for human consumption	2.00	*	1.00	*
Canned vegetables	*	*	0.10	*
Foods and formulas for infants				
Cereal-based products for child feeding (infants and young children)	0.05	*	*	0.05
Transitional products for infants and early childhood children	0.15	*	*	*
Pediatric formula for enteral nutrition	0.01	*	*	*
Nutrient formulas presented or indicated for high-risk newborns	0.01	*	*	*

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Follow-up formula for infants and early childhood children	0.01	0.20	0.01	0.01
Formula aimed at specific dietary needs	0.01	0.15	0.01	0.01
Infant formula	0.01	0.20	*	*
Other foods specially formulated for infants and young children	0.01	*	*	*
Beverages				
Fermented and yeast-distilled alcoholic beverages, except wine	0.20	*	*	*
Non-alcoholic beverages, excluding fruit juices and nectars	0.05	0.30	*	*
Fruit juices and nectars	0.05	0.05	0.03	0.03
Grape juice	*	0.04	0.04	*
Wine	0.15	0.50	0.10	0.15
Coffees				
Soluble coffee powder or granules	1.00	*	*	*
Roasted coffee beans and powder	0.50	0.50	*	*
Meat, meat products, derivatives, and eggs.				
Meat of bovines, sheep, pigs, goats and poultry, raw, frozen or chilled derivatives, processed meats, and raw breaded products	0.10	0.20	0.10	0.10
Liver of bovines, sheep, pigs, goats and poultry	0.50	0.50	*	*
Eggs and egg products	0.10	0.20	*	*
Kidneys of bovines, sheep, pigs, goats	0.50	0.50	*	*
Chocolates and cocoa products				
With more than 40% cocoa	0.40	0.50	*	*
Less than 40% cocoa	0.20	0.50	*	*
Cocoa paste	0.50	0.50	*	*
Mushrooms				
Genus *Agaricus, Pleurotus and Lentinula or Lentinus*	0.30	0.50	0.30	0.30
Except those of the genus *Agaricus, Pleurotus and Lentinula or Lentinus*	0.10	1.0	*	*
Fruit				
Canned	*	*	0.10	*
Fresh berries and of small size	0.20	*	0.10	*

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Fresh, excluding berries and of small size	0.10	0.10	0.10	0.10
Gooseberries	*	0.20	0.20	0.20
Grains and derivatives				
Rice and its derivatives, except oil	0.20	0.20	0.20	0.20
Cereals and cereal products, excluding wheat, rice and their derived products and oils	0.20	0.20	0.20	0.20
Roots and tubers	0.10	0.20	0.10	*
Soybeans in grains	0.20	0.30	*	*
Wheat and its derivatives, except oil	0.20	*	*	*
Vegetables				
Brassica genus, excluding loose-leaf	0.30	0.20	0.10	0.30
Leafy, including loose-leaf Brassicas, and fresh aromatic herbs	0.30	0.30	0.30	0.30
Fruits with sheathed leaves	0.10	*	0.10	*
Fruits of the family *Cucurbitaceae*	0.10	0.10	*	*
Other fruits of the *Cucurbitaceae* family	0.10	0.10	0.05	0.10
Pulses	0.10	0.20	0.10	0.20
Milk and dairy products				
Cream	0.10	0.20	*	*
Cheeses	0.40	0.20	*	*
Condensed milk and dulce de leche	0.10	*	*	*
Edible offals				
Of bovines	*	*	0.20	*
Of swines	*	*	0.15	*
Of poultry	*	*	0.10	*
Except liver and kidneys	0.50	0.50	*	0.50
Fish				
Crustaceans	0.50	1.5	*	0.50
Bivalve mollusks	1.50	1.50	*	1.50
Cephalopod mollusks	1.00	1.00	*	0.30
Raw, frozen or chilled fish	0.30	0.50	0.30	*
Ice cream				
Fruit-based	0.07	0.20	*	*
Flavored water	0.05	0.30	*	*

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Milk or cream	0.10	*	*	*

#Considered as 'fresh vegetables'.

When looking at Table 2, it can be seen that not all foods are included in the four listed legislations. Most of the foods listed in the different legislations presented similar or very close maximum levels of Pb as observed in the group of chocolates, fruits, grains and derivatives, and vegetables. However, variations were observed for some foods.

It was observed that in China, sometimes, the ML of Pb are higher than those presented in the other legislations, especially in Brazil. The greatest difference seen was in the ML for the category of foods and infant formulas, in which 3 formulas draw attention when compared to the legislations of Brazil and China. The latter determines more permissive values (up to 20 times higher), while Brazil is aligned with the *Codex Alimentarius* and the European Union, when available.

A significant difference was also observed for teas, yerba mate and other vegetables for infusion, which in Chinese legislation have a ML of 5.0 mg/kg, a value above 8 times higher than in Brazilian legislation (0.60 mg/kg). The greater flexibility in legislation may be related to the high production of tea in China. In 2021, according to the Food and Agriculture Organization's Corporate Statistical Database (FAOSTAT, 2021), China produced 14,812,000 tons of tea. According to Chen et al. (2020), tea consumption influences the economy and geographic vectors of the Region.

A 6 times higher proportion of Pb is tolerated in non-alcoholic beverages, excluding fruit juices and nectars, in China when contrasted with ML in Brazil. In China, the ML in sugars is 0.5 mg/kg, while in Brazil it is 0.1 mg/kg. That is, China presents legislation 5 times more permissive than that of Brazil for this food. It is worth noting that this food is highly consumed. Both non-alcoholic beverages and sugars did not have ML determined in *Codex Alimentarius* and European Union legislation. Still in the group of beverages, wine presented ML more than three times higher in the legislation of China when compared to the legislation of Brazil and the European Union, and five times higher when compared to the ML present in the *Codex Alimentarius*.

In the group of beverages, only Brazilian legislation presented ML for fermented and yeast-distilled alcoholic beverages, except wine. The legislations of China, European Union and *Codex Alimentarius* did not present ML for these foods.

On the other hand, in nuts, including walnuts, pistachios, hazelnuts, macadamia nuts and almonds, the listed ML is four times higher in Brazil than in China. The *Codex Alimentarius* and European Union legislation did not determine limits for the presence of Pb in these foods.

3.4 Impacts of Pb contamination on public health

It is estimated that human exposure to Pb contributes to about 21.7 million years lost due to death or disability worldwide, as the effects of its accumulation in the body occur in the long term (OMS, 2016).

In 2017, Pb exposure caused about 1,050,000 deaths worldwide, in addition to promoting a

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significant increase in the burden of disease, classifying it as a human carcinogen (GBD 2017 Risk Factor, 2018).

In addition to affecting individuals, transgenerational studies have shown results where health implications are also progressive and affect the offspring of those who are affected by Pb (Li et al., 2019).

A study carried out with schoolchildren who had learning difficulties and significantly increased levels of plasma malondialdehyde (MDA) identified high plasma levels of Pb, which were higher than those recommended by the WHO (Nascimento et al., 2014).

Reuben *et al.* (2017) conducted a study analyzing the association between Pb exposure in childhood and its consequences in adulthood. It was observed that children with higher blood Pb levels had worse cognitive performance in adulthood and lower socioeconomic status. Adults followed for nearly 3 decades had lower IQ scores, reflecting cognitive decline and impacts on their social lives.

Wacewicz-Muczyńska *et al.* (2021) conducted a study analyzing blood levels of Pb, Cd and Hg in patients with psoriasis and vitiligo and observed an increase in these heavy metals, also emphasizing that the main means of accumulation was through food. Frequent consumption of canned fish in patients with vitiligo and frequent consumption of hot dogs in patients with psoriasis have been observed to increase blood levels of Pb. These results are of great relevance to the public health of the general population, since patients affected by these conditions should pay greater attention to the consumption of some foods that contain a higher content of heavy metals.

The association between exposure to Pb, arsenic (As), Cadmium (Cd) and Mercury (Hg) was investigated in relation to blood pressure (BP) levels and the prevalence of hypertension among adults in the United States of America (USA) who participated in the National Health and Nutrition Examination Survey 2011-2018 (NHANES) and the results showed a positive association between blood Pb levels and the presence of elevated BP and prevalence of hypertension (AH) (Tang et al., 2022).

Due to existing legislation and inspections around the world, acute Pb poisoning has decreased, however, the problems and consequences of intoxication have been rising among researchers in the field of public health policies. Chronic Pb poisoning is still common in developing countries due to frequent exposure to this metal, which is present in their housing area or work environment (Dascanio et al., 2016).

Some actions should be aimed at prevention that precedes Pb intoxication, and these health promotion actions are often done through health education of the population, as well as satisfactory living conditions (including housing, food, leisure, family planning), satisfactory nutritional conditions, and food and nutritional security.

If damage related to lack of treatment or high level of exposure to Pb is identified, individual rehabilitation measures should be planned (Dascanio et al., 2016).

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4 CONCLUSION

Lead, as a food contaminant, is a serious threat to public health, since its effects are often manifested in the long term, not enabling early interventions. The main route of exposure is through food, which requires a greater monitoring of the levels of this contaminant in food through greater rigor in current legislation, considering the regionalism, the singularities of the population, and the frequency of food consumption, enabling greater control in the production and marketing of foods that are more susceptible to Pb contamination.

Some actions should be aimed at prevention that precedes Pb intoxication, and these health promotion initiatives are often done through health education of the population, as well as satisfactory living conditions (including housing, food, leisure, family planning), satisfactory nutritional conditions, and food and nutritional security.

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