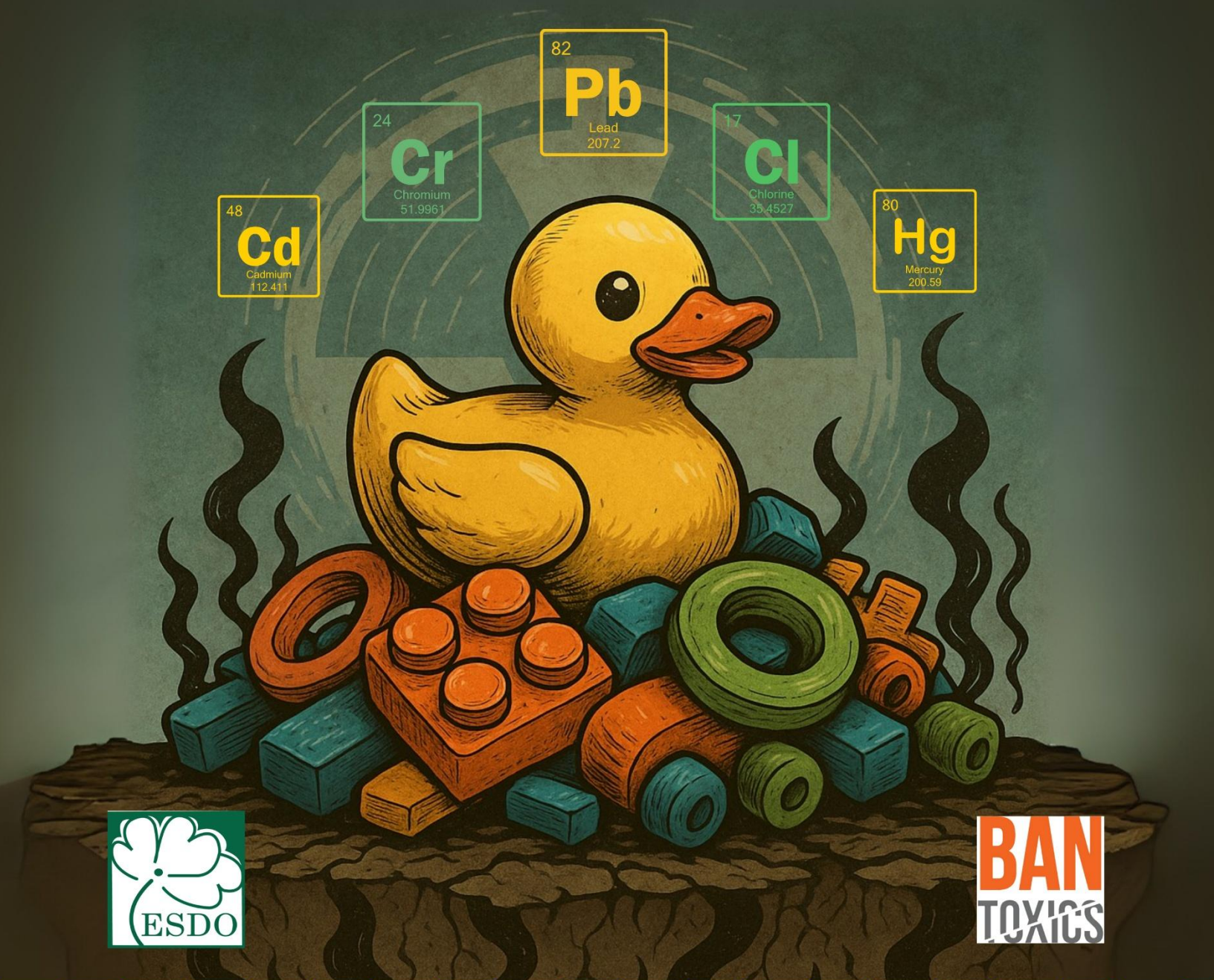
Toxic Playtime

UNCOVERING HEAVY METALS IN CHILDREN'S PLASTIC TOYS



ESDO

BAN TOXICS

Toxic Playtime: Uncovering Heavy Metals in Children's Plastic Toys

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About ESDO

Environment and Social Development Organization- ESDO is an action research-oriented non-profit and non-government organization based in Bangladesh. It is an environmental action research group dedicated to a toxic-free, zero-waste planet. This entails fighting pollution and building regenerative solutions in cities through local campaigns, shifting policy and finance, research and communication initiatives, and movement building. ESDO is working relentlessly to ensure biological diversity since its formation in 1990. It is the pioneer organization that initiated the anti-polythene campaign in 1990, which later resulted in a complete ban on polythene shopping bags throughout Bangladesh in 2002.

About BAN Toxics

BAN Toxics is a Philippine-based environmental NGO founded in 2006, dedicated to promoting environmental justice, health, and sustainable development through sound chemicals and waste management. The organization focuses on protecting vulnerable groups, especially women and children, by conducting scientific research, advocating for policy reforms, and raising public awareness about toxic substances in everyday products.

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Disclaimer

This report, *"Toxic Playtime: Uncovering Heavy Metals in Children's Plastic Toys,"* has been prepared through a collaborative research initiative by the Environment and Social Development Organization (ESDO) and BAN Toxics. The content, findings, and recommendations are based on field data, laboratory screenings, and policy analysis conducted during the project period. Every effort has been made to ensure the accuracy, reliability, and objectivity of the information presented. However, the authors do not assume responsibility for any consequences arising from the use of this information.

The views expressed in this report are solely those of the authors and do not necessarily reflect the positions of any government agency, donor, or affiliated organization. While the findings are supported by scientific methods, including XRF analysis, they are not intended to serve as a substitute for regulatory testing or legal certification.

The report is intended for informational, educational, and advocacy purposes only. It aims to raise awareness, inform policy discussions, and contribute to the broader dialogue on children's environmental health and consumer safety. Readers are advised to consult relevant national and international regulatory authorities for official standards and compliance requirements.

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Executive Summary

Toys, essential for nurturing the cognitive, emotional, and social development of children, have tragically become silent carriers of toxic substances in Bangladesh. This investigative report, undertaken by the Environment and Social Development Organization-ESDO and BAN Toxics, Philippines, exposes a disturbing pattern of systemic contamination in plastic toys available in the Bangladeshi market. The findings reveal that many toys especially those manufactured informally or imported from low-regulation regions contain dangerously high levels of heavy metals such as lead (Pb), cadmium (Cd), chromium (Cr), mercury (Hg), arsenic (As), and antimony (Sb), along with chlorine (Cl) and bromine (Br), indicative of hazardous materials like PVC and brominated flame retardants (BFRs).

The study deployed X-Ray Fluorescence (XRF) screening on 70 samples sourced primarily from Dhaka's Chawkbazar, the country's largest toy distribution hub. The results were deeply alarming: over two-thirds of toys exceeded international safety thresholds for at least one toxic element, with some toys violating limits for up to five different metals simultaneously. Notably, several locally produced toys surpassed permissible levels by up to 70 times, revealing systemic safety violations embedded in Bangladesh's unregulated toy industry.

This toxic burden is exacerbated by Bangladesh's regulatory vacuum. There are currently no legally enforceable standards for chemical safety in toys, no mandatory testing mechanisms, no labeling requirements, and no formal recall procedures. Informal manufacturers frequently use recycled plastic sourced from e-waste and industrial scrap, materials that inherently contain toxic residues. Meanwhile, imported toys from countries such as China and India often arrive without chemical safety reports or origin traceability, further compounding the crisis.

Children, particularly those under five, are at heightened risk. Their developing brains, frequent hand-to-mouth behavior, and immature detoxification systems make them especially vulnerable to even low levels of exposure. Chronic ingestion or dermal contact with heavy metals and chemical-laden plastics can lead to irreversible neurodevelopmental deficits, behavioral disorders, kidney dysfunction, and long-term cancer risks.

Moreover, the environmental repercussions are equally dire. The open burning, informal recycling, and improper disposal of toys release heavy metals and toxic compounds into the air, soil, and water. These pollutants enter food chains, contaminate staple crops and fish, and cycle back into children's bodies, thus creating a loop of toxic exposure that persists long after a toy is discarded.

This report is both a scientific exposé and a public health alarm. It advocates for urgent policy reform through the establishment of legally binding national toy safety standards, mandatory chemical testing, manufacturer accountability, and public awareness campaigns. If left unaddressed, this crisis threatens to undermine decades of progress in child development, environmental justice, and consumer safety in Bangladesh.

Key Findings

- Over **70% of the 70 tested plastic toys** contained heavy metals above international safety limits. **Chromium (Cr) and antimony (Sb)** were the most common contaminants.
- Extreme Violations:
    - Some toys exceeded limits by 10 to 70 times, such as:
    - Chromium: 4300 ppm (limit: 60 ppm)
    - Lead: 2350 ppm (limit: 90 ppm)
    - Mercury: 1080 ppm (limit: 60 ppm)
    - Cadmium: 640 ppm (limit: 75 ppm)
- 100% of toys tested from manufacturers such as **Aman Toy Garden, Khokon Plastick Products**, and **Shahjalal Toys Gallery** exceeded permissible limits. Locally produced toys were more hazardous than imported ones.
- **Over 20%** of toys contained **chlorine or bromine above 1,000 ppm**, indicating use of **PVC plastics and brominated flame retardants (BFRs)**, both associated with endocrine disruption and thyroid toxicity.
- Children's Health at Risk:
    - Heavy metal exposure can cause:
    - IQ loss, speech, and language delays
    - Kidney dysfunction and immune suppression
    - Behavioral disorders and attention deficits
    - Increased lifetime cancer risk
- Bangladesh lacks binding toy safety laws, chemical content standards, import screening, or national recall mechanisms. Toys are not subject to routine inspections by BSTI or customs authorities.
- Brightly colored toys are perceived as safe despite their association with high lead, cadmium, and chromium levels. Parents lack information on toxic materials or safety labeling.
- Improper disposal and burning of toys release toxins into air, soil, and water. Contaminants re-enter the food chain through crops, fish, and groundwater, creating a toxic loop.
- Many toys sold in Bangladesh would be banned under EU's EN 71-3, US CPSIA, or ISO 8124-3 standards, highlighting Bangladesh's position as a toxic dumping ground.
- The study highlights an urgent need for strong national regulations, routine testing, public awareness, and manufacturer accountability.

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Chapter One

Introduction

1.Introduction

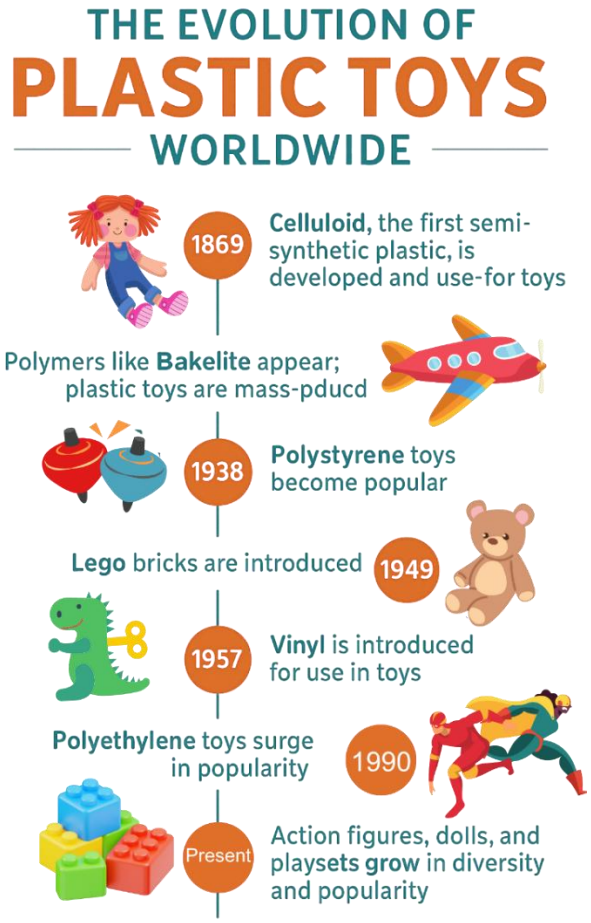
Toys play a pivotal role in early childhood, fostering motor skills, creativity, and emotional development. But when playthings are contaminated with toxic chemicals, they transform from sources of joy into hidden threats. Across the world and especially in low-regulation environments like Bangladesh, plastic toys have repeatedly been found to contain hazardous levels of lead, cadmium, chromium, arsenic, and mercury. These substances are linked to neurological damage, cancer, organ failure, and behavioral disorders in children.

In Bangladesh, where chemical safety in consumer products remains underregulated, toys are often manufactured or imported without any toxicological screening, placing millions of children at daily risk.

1.1. Toys Through Time: A Historical Perspective

Toys have accompanied human civilization for over four millennia, serving as tools of education, imagination, and socialization. Archaeological discoveries from ancient Mesopotamia, Egypt, and the Indus Valley reveal that children played with dolls, carts, and animal figurines carved from clay, stone, or ivory1. As societies evolved, toys reflected changing cultural and technological trends from wooden spinning tops and tin soldiers in the 18th and 19th centuries to the post-WWII explosion of plastic toys, which became globally dominant by the 1970s2.

However, this shift toward plastics introduced a new class of risks. Toy manufacturers increasingly relied on synthetic additives-colorants, flame retardants, and stabilizers many of which included toxic heavy metals. Over the past two decades, studies have repeatedly shown that toys made with low-quality recycled plastic or industrial scrap often contain dangerous levels of lead (Pb), cadmium (Cd), chromium (Cr), arsenic (As), and mercury (Hg)3.



1 Payne, A., & Hund, E. (2015). Toxic metals in children's toys. Environmental Research, 138, 373–383.

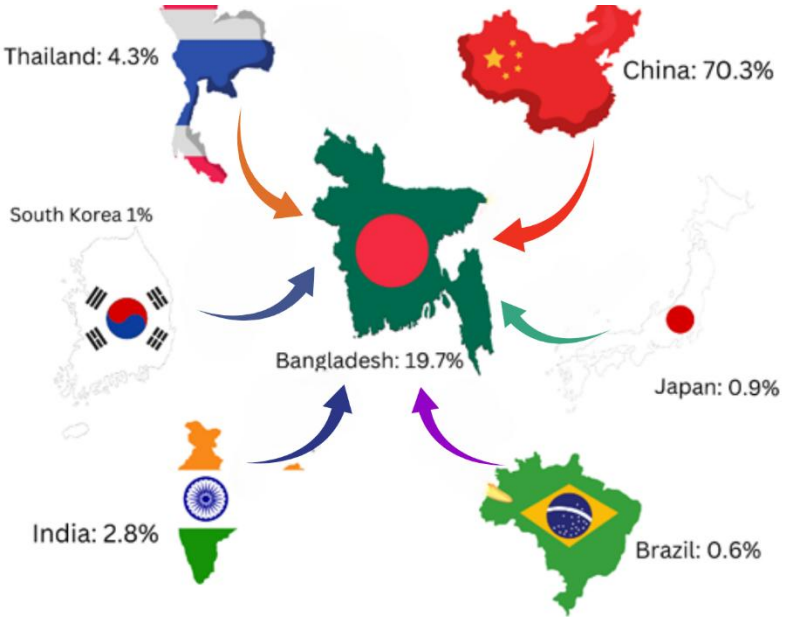
2 EnvironBuzz. (2023). Heavy Metals in Children's Toys: A Hidden Danger. https://environbuzz.com

3 Adie, G. U., et al. (2023). Total and bio-accessible toxic metals in low-cost children toys. Environmental Research, 138, 300–309.

1.2. Toy Manufacturing in Bangladesh: A Largely Informal Sector and Toxic Exposure Risks

Bangladesh's plastic toy industry is sprawling yet largely informal, driven by low-cost production and minimal regulatory oversight[1]. Manufacturers include small-scale workshops clustered in Chawkbazar (Old Dhaka), Narayanganj, and Chattogram as well as larger formal companies like *Zihan Plastic Industries* and *Everest Toys Industries*[2]. These informal manufacturers rely heavily on recycled plastic, often sourced from e-waste, industrial scrap, or used containers[3]. Without chemical controls, such plastic may already contain lead, cadmium, chromium, and other toxic elements4. The resulting toys, brightly colored and unlabeled, are sold across street stalls, footpath vendors, and informal markets nationwide5.

Produced and Imported Toys in Bangladesh



In parallel, Bangladesh imports a significant volume of plastic toys, mostly from China, along with India, Brazil, and other Southeast Asian countries6. A 2023-2024 survey by *The Business Standard* reported that imported toys make up around 35% of Dhaka's plastic toy market7. Despite the Bangladesh Standards and Testing Institution (BSTI) issuing safety guidelines, chemical safety checks at customs remain sporadic or absent, and many imports arrive without test reports, batch numbers, or chemical labeling8.

4 Suwal, S., et al. (2023). Assessment of Toxic Heavy Metal Content in Children Toys. Khwopa Journal.
5 TBS News. (2024). Plastic toys in Bangladesh contain alarming levels of toxic metals. https://www.tbsnews.net
6 ESDO. (2024). Toxic Toys in Bangladesh: A Chemical Threat to Child Health.
7 The Business Standard. (2024). 35% of Toys Sold in Bangladesh Are Imported. https://tbsnews.net
8 ESDO. (2024). Toxic Toys in Bangladesh: A Chemical Threat to Child Health. https://esdo.org

1.3. Findings from ESDO and BAN Toxics Previous Investigations

In two major studies conducted by the Environment and Social Development Organization-ESDO and BAN Toxics, one in 2013-14 and another in 2023-24, researchers documented alarming trends:

- 63% of 250 sampled children's products contained detectable levels of lead.
- 59% of these exceeded 90 ppm, the U.S. CPSIA safety limit (comparable to EU and ISO standards).
- Lead levels reached up to 1,380 ppm, arsenic up to 247 ppm, and chromium 1,390 ppm in common products like water mugs and educational toys.
- Even major toy stores were found selling high-end doll sets with lead (500 ppm) and chromium (1,500 ppm) levels9.

Table 1. Key Toxic Metal Levels Detected in Sampled Products

(All values in ppm)

Product Type	Lead (Pb)	Arsenic (As)	Chromium (Cr)	Cadmium (Cd)
Water mug	1,380	247	1,390	—
Stationery bag	580	—	—	—
Doll set	160	—	1,500	—
High-end doll	500	—	—	—
Alphabet letter pad	660	—	—	—
Another mug	220	—	1,680	315

Source: ESDO (2024); BAN Toxics (2024)

These levels far exceed international safety limits, including 13.5 ppm for lead, 25 ppm for arsenic, and 60 ppm for chromium, as defined in EN 71-3, U.S. CPSIA, and ISO 8124-310.

Children, particularly under age five, are more vulnerable to these toxins due to frequent mouthing behaviors, higher absorption rates, and immature detoxification systems. Chronic ingestion of lead is linked to irreversible neurodevelopmental delays, behavioral disorders, and kidney

9 BAN Toxics & ESDO. (2024). Toxic Toy Screening Report (Phase 2). Internal Study.
10 ISO. (2023). ISO 8124-3: Migration of Certain Elements in Toys.

damage. Cadmium and chromium are classified as carcinogens, while arsenic exposure contributes to systemic toxicity and cancer risks[11].

Despite the mounting evidence, Bangladesh lacks binding legal limits on heavy metals in toys. The 90ppm lead limit for decorative paint is not extended to industrial paints or plastics, the materials most commonly used in toy production[8]. Only an estimated eight factories nationwide have any form of environmental clearance, which generally covers emissions rather than chemical safety of products[8]. This regulatory vacuum leaves children across Bangladesh dangerously exposed.

1.4. Study Objectives: Measuring the Chemical Threat

1. Detect and quantify toxic heavy metals (Pb, Cd, Cr, As, Hg, Sb) in plastic toys commonly sold in Bangladeshi markets.
2. Assess whether these levels exceed limits set by international toy safety standards, such as the EU Toy Safety Directive.
3. Examine exposure risk through child-specific behaviors, especially frequent mouthing and chewing of toys.
4. Identify contamination patterns based on toy type, color, country of origin, and manufacturer.
5. Recommend practical and policy-based interventions to ensure chemical safety in toys sold in Bangladesh.

1.5. Rationale of the Study: Bridging the Policy and Safety Gap

This study was initiated in response to the urgent need for systematic chemical safety surveillance in Bangladesh's toy sector. With increasing reports of heavy metal contamination in both domestic and imported toys, and in the absence of effective government regulation, it is imperative to generate concrete, evidence-based data to:

- **Quantify toxic heavy metal concentrations** in toys sold across Dhaka and other major urban markets.
- **Assess health risks** from common exposure routes, especially among children.
- **Compare contamination levels** against global safety benchmarks to identify policy gaps.
- **Inform national stakeholders,** including the Ministry of Health, BSTI, import authorities, and civil society, about the need for immediate regulatory action.

The findings will also support advocacy for a **comprehensive toy safety regulation** in Bangladesh that incorporates chemical standards aligned with international conventions and bans the use of high-risk materials in children's products. Ultimately, the study aims to protect child health and uphold the **right to safe play**.

11 The Financial Express. (2024). High-End Toys Found with Unsafe Lead and Chromium. https://thefinancialexpress.com.bd

Chapter Two

More Than Play

Why Safe Toys Are a Matter of Child Development and Public Health?

2. More Than Play: *Why Safe Toys Are a Matter of Child Development and Public Health?*

Toys are more than playthings; they are essential tools that support a child's cognitive, emotional, social, and physical development. Through interactive play, children cultivate foundational life skills such as problem-solving, creativity, emotional regulation, and social interaction.

According to the American Academy of Pediatrics, **toys significantly aid in "language acquisition, spatial awareness, and social role-play," reinforcing their value in early learning**.[12]

Despite these benefits, increasing global evidence shows that many toys, particularly low-cost plastic ones, may be contaminated with hazardous substances such as lead, cadmium, chromium, and mercury.[13] Children, due to their developing organs and frequent hand-to-mouth behavior, are particularly vulnerable.

The World Health Organization notes that **children "absorb more toxins per body weight" and have underdeveloped detoxification systems, making them highly susceptible to toxic effects.**[14]

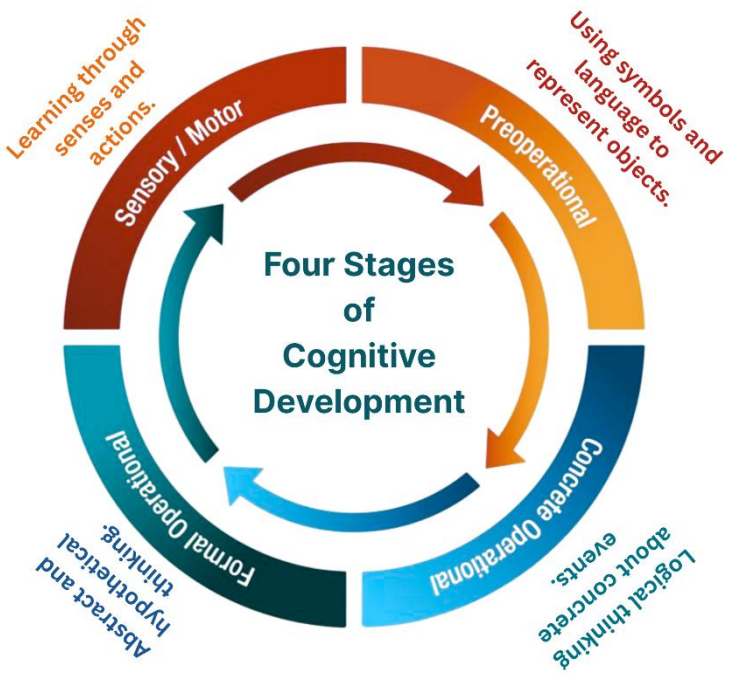
In Bangladesh, informal plastic recycling practices and limited regulatory oversight have created a high-risk environment where contaminated toys often reach children. Exposure to heavy metals in early life can result in permanent damage, including neurodevelopmental delays, learning disabilities, and behavioral disorders. These issues go beyond health, raising critical concerns about children's rights to safe developmental environments.[15] Effective regulation, public awareness, and safer manufacturing practices are urgently needed.

12 American Academy of Pediatrics. (2021). *The Power of Play: A Pediatric Role in Enhancing Development in Young Children*.
13 CDC (Centers for Disease Control and Prevention). (2012). *Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention*.
14 World Health Organization. (2010). *Children's Environmental Health*.
15 Berk, L. E. (2009). *Child Development* (8th ed.). Pearson Education.

2.1 Importance of Toys in Child Development: Cognitive, Emotional, and Social Skills

2.1.1. Cognitive Development

Toys significantly influence the architecture of a child's brain, especially during the early years when neurodevelopment is most active. Engaging with puzzles, building blocks, shape sorters, and other educational toys fosters essential cognitive functions such as spatial reasoning, memory consolidation, cause-and-effect understanding, and logical problem-solving.[16]



For example, children who frequently play with construction toys demonstrate higher performance in spatial cognition and mathematics in later schooling years. [17]

Problem-Solving & Critical Thinking:

Toys like puzzles and building blocks encourage children to achieve goals through trial and error, enhancing logical reasoning, strategic thinking, and cognitive flexibility. Children who regularly play with puzzles score higher on problem-solving tests and demonstrate greater adaptability in new situations. A Developmental Psychology study found that children who played with puzzle toys between the ages 2-4 performed significantly better on spatial intelligence tests at age 5. These spatial skills are strongly linked to future success in STEM fields (Science, Technology, Engineering, Mathematics). [18]

16 Grandjean, P., & Landrigan, P. J. (2014). Neurobehavioural effects of developmental toxicity. *The Lancet Neurology*, 13(3), 330–338.

17 Verdine, B. N., Irwin, C. M., Golinkoff, R. M., & Hirsh-Pasek, K. (2014). Contributions of block play to children's spatial and mathematical thinking: A review. *Child Development Perspectives*, 8(2), 91–96.

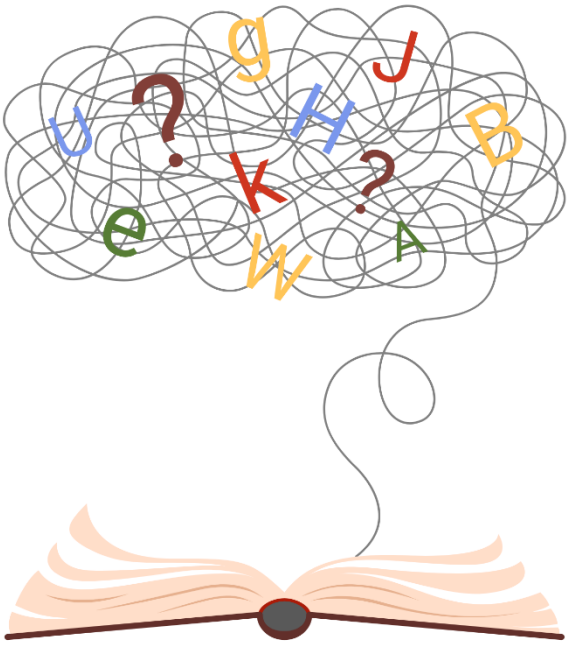
18 Verdine, B. N., Irwin, C. M., Golinkoff, R. M., & Hirsh-Pasek, K. (2014). Contributions of block play to children's spatial and mathematical thinking: A review. *Child Development Perspectives*, 8(2), 91–96.

Spatial Reasoning & Mathematical Skills:

Educational toys such as shape sorters, blocks, and puzzles help children understand how things work, build abstract concepts, and strengthen spatial and mathematical reasoning.

Language Development:

Toys like interactive books, talking games, and sound-emitting toys play a crucial role in: vocabulary building, narrative comprehension, and early literacy skills.



Furthermore, interactive and sensory toys stimulate synaptic growth in regions responsible for executive function and attention span. Language-based toys such as talking books or phonetic games support early vocabulary acquisition and comprehension skills, which are directly linked to school readiness and future academic outcomes.[19]

However, exposure to neurotoxic substances in toys, particularly lead, arsenic, and mercury, undermines these cognitive gains. Heavy metals interfere with neurogenesis, disrupt neurotransmitter signaling, and reduce synaptic plasticity.[20] Evidence from longitudinal studies shows that children with elevated blood lead levels score significantly lower in reading and math and are more likely to require special education services.[21] In countries like Bangladesh, toys made from poorly regulated recycled plastics often contain harmful chemicals that silently erode children's intellectual potential.

19 Zosh, J. M., Hirsh-Pasek, K., Hopkins, E. J., Jensen, H., Liu, C., Neale, D., Solis, S. L., & Whitebread, D. (2015). Learning through play: A review of the evidence. *Lego Foundation White Paper*.

20 Levine, S. C., Ratliff, K. R., Huttenlocher, J., & Cannon, J. (2012). Early puzzle play: A predictor of preschoolers' spatial transformation skill. *Developmental Psychology*, 48(2), 530–542.

21 Needleman, H. L., Schell, A., Bellinger, D., Leviton, A., & Allred, E. N. (1990). The long-term effects of exposure to low doses of lead in childhood. *New England Journal of Medicine*, 322(2), 83–88.

2.1.2. Emotional Development

Toys also play a crucial role in shaping children's emotional intelligence. Through role-play and imaginative scenarios using dolls, plush toys, or miniature figures, children learn to name, express, and regulate emotions. Toys offer safe contexts to mimic caregiving behaviors, reenact social interactions, and practice empathy, skills fundamental to emotional maturity. Emotional resilience, self-esteem, and stress management are all cultivated through symbolic and therapeutic play. [22]

However, chemical contaminants in toys can severely disrupt this developmental trajectory. Chronic exposure to toxic substances such as lead and cadmium has been associated with mood dysregulation, impulsivity, anxiety, and depressive symptoms in children.[23]

Emotional Expression:

Toys like dolls, action figures, or puppets allow children to act out feelings and daily experiences, express emotions such as anger, joy, fear, or sadness safely and develop emotional vocabulary through storytelling and pretend play.

Empathy and Social Understanding:

Role-playing toys and games promote: understanding of others' perspectives, sharing, cooperation, and turn-taking, and development of empathy and prosocial behavior.

Stress Relief and Emotional Regulation:

Toys provide a comforting outlet during stressful times, repetitive play (e.g., stacking blocks, coloring) helps children, self-soothe and calm down, learn to manage frustration and delay gratification.

Building Emotional Resilience:

Through trial-and-error in play, children learn: how to cope with failure or mistakes, how to adapt to new situations, and persistence, confidence, and emotional strength.

Strengthening Attachment and Bonding:

Playing with caregivers or peers enhances secure attachment and provides opportunities for emotional connection, creating a safe space for communication and affection.

22 Ginsburg, K. R. (2007). The importance of play in promoting healthy child development and maintaining strong parent-child bonds. *Pediatrics*, 119(1), 182–1891.

23 Boucher, O., Muckle, G., & Bastien, C. H. (2009). Prenatal exposure to methylmercury and neurodevelopment. *Neurotoxicology*, 30(6), 1071–1079.

Trauma Processing:

For children who have experienced distress, toys enable symbolic play to process trauma, they allow expression of complex or suppressed emotions, and encourage emotional healing in therapeutic and natural settings.[24]

In such contexts, the absence of safe toys becomes a barrier to expressing inner conflicts, processing trauma, and building emotional security.

24 Russ, S. W. (2004). *Play in Child Development and Psychotherapy: Toward Empirically Supported Practice*. Lawrence Erlbaum Associates.

2.1.3. Social Development

Play is a child's first classroom for learning social norms. Toys that encourage group engagement, such as board games, kitchen sets, and cooperative construction kits, teach essential interpersonal skills: turn-taking, conflict resolution, active listening, and teamwork. According to sociocultural learning theories, these peer interactions through toys create a foundation for empathy, moral reasoning, and cultural learning.[25]

Children in both formal educational settings and community centers that incorporate socially interactive toys exhibit improved peer cooperation, verbal expression, and social adaptability.[26]

Encourages Social Interaction:

Toys like board games, building sets, or pretend-play kits promote cooperative play and shared experiences. Children learn how to negotiate roles, take turns, and work as a team.[27]

Develops Communication Skills:

Playing with others requires verbal and non-verbal communication; children practice listening, expressing thoughts, and interpreting social cues during group play.

Builds Empathy and Understanding:

Role-playing toys (e.g., dolls, doctor sets) help children: imagine and understand others' feelings, and practice kindness, helping behaviors, and conflict resolution.

Supports Peer Relationships:

Regular play helps children develop: friendships, a sense of belonging. Skills for navigating social dynamics and group inclusion

Teaches Social Norms and Rules:

Structured games and rule-based play (e.g., card games, sports toys) introduce concepts of fairness, rule-following, and self-regulation. Understanding of the consequences of actions in a social context.[28]

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25 Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.
26 UNICEF ROSA. (2016). *Early Childhood Development in South Asia: Investing Better, for Equity and Growth*.
27 Pellegrini, A. D., & Smith, P. K. (2007). *The Nature of Play: Great Apes and Humans*. Guilford Press.
28 Frost, J. L., Wortham, S. C., & Reifel, S. (2012). *Play and Child Development* (4th ed.). Pearson Education.

In Bangladesh, early childhood development programs have shown that socially enriching toys significantly reduce behavioral problems and increase school participation.

However, the presence of toxic chemicals in toys undermines these social gains. Health effects such as behavioral aggression or attention disorders caused by toxic exposure can lead to social isolation, stigmatization, or bullying. A child who becomes disruptive or withdrawn due to neurotoxic exposure may struggle with peer acceptance, weakening their social integration. [29]

Additionally, unsafe toys lead to broader community mistrust. When caregivers avoid sharing toys in group settings due to chemical concerns, children miss out on cooperative play. This deprivation can result in delays in social-emotional learning and reduced opportunities for cultural bonding and inclusion.

2.2. Children's Physiological Vulnerability: The Case for Safe Toys

Children are biologically and behaviorally more vulnerable to the harmful effects of toxic substances than adults. Their bodies are still growing, and many physiological systems, including the brain, immune system, and liver, are immature, making it harder for them to detoxify and eliminate harmful substances. As a result, exposure to even small doses of toxic chemicals can cause disproportionately severe health outcomes in children.

Children also exhibit behaviors such as mouthing toys and putting their hands in their mouths, which significantly increases their risk of ingesting harmful substances like heavy metals present in contaminated plastic toys. According to the World Health Organization, infants and toddlers can absorb lead four to five times more efficiently from a given source than adults (WHO, 2010).[2] Moreover, a child's higher respiratory and metabolic rate means they intake more air, food, and water per kilogram of body weight, further elevating exposure risk.[30]

29 Liu, J., Li, L., Wang, Y., Yan, C., Liu, X., & Yan, C. (2014). Chronic lead exposure alters emotional behaviors and neurochemical changes in the brain of rats. *Neuroscience*, 268, 1–8.

30 Landrigan, P. J., & Goldman, L. R. (2011). Children's vulnerability to toxic chemicals: a challenge and opportunity to strengthen health and environmental policy. *Health Affairs*, 30(5), 842–850.

Once absorbed, toxicants like lead and cadmium can cross the blood-brain barrier and accumulate in brain tissue, interfering with brain development during sensitive growth periods. Studies have shown that early-life exposure to neurotoxic chemicals results in long-term deficits in attention, memory, and impulse control.[31] These outcomes not only affect individual children but also impose long-term social and economic costs on families and health systems.

The risks are particularly alarming in developing countries like Bangladesh, where the regulation of toy manufacturing is weak and informal markets thrive. Toys made from recycled e-waste or low-quality plastics may contain residual heavy metals, flame retardants, or phthalates, none of which are safe for children. In the absence of comprehensive testing and labeling standards, parents unknowingly purchase toys that could harm their children's health.

Ensuring toy safety is not just a matter of consumer protection; it is a public health imperative and a moral responsibility.[32] Governments, manufacturers, and civil society must collaborate to establish stronger regulatory frameworks, promote safer materials, and enforce testing standards that prioritize the unique physiological vulnerabilities of children.

31 Bellinger, D. C. (2008). Very low lead exposures and children's neurodevelopment. *Current Opinion in Pediatrics*, 20(2), 172–177

32 IPEN. (2021). Toxic Toy Imports in South Asia: Regulatory Gaps and Consumer Safety.

Chapter Three

Regulating Play

Global Standards and Local Gaps in Toy Safety

3. Regulating Play: Global Standards and Local Gaps in Toy Safety

Toys are not merely sources of entertainment for children; they are developmental tools essential to learning, creativity, and well-being. However, the presence of hazardous chemicals such as lead, cadmium, chromium, mercury, and phthalates in toys has raised significant global and national concern.[33] This section outlines the international and national regulatory frameworks designed to protect children from chemical hazards in toys, while highlighting the gaps and challenges in implementation.

3.1. International Toy Safety Standards: EU, US, ISO, and WHO Guidelines

Globally, various regulatory bodies have established comprehensive standards to minimize chemical hazards in children's toys. These frameworks specify limits for toxic substances, including heavy metals, and mandate safety testing and certification.

3.1.1. European Union (EU)

The European Union enforces strict safety requirements for toys under the Toy Safety Directive 2009/48/EC.[34] Specific chemical limits are detailed in the harmonized standard EN 71-3, which restricts the migration of heavy metals:

Table 1: EU Limits for Heavy Metals in Toys

Substance	Dry/Pliable Materials	Liquid Materials	Scraped-Off Materials
Lead	2.0 mg/kg	0.5 mg/kg	23 mg/kg
Cadmium	1.3 mg/kg	0.3 mg/kg	17 mg/kg
Chromium VI	0.2 mg/kg	0.05 mg/kg	0.2 mg/kg
Mercury	1.5 mg/kg	0.5 mg/kg	94 mg/kg

Additionally, the REACH Regulation (Registration, Evaluation, Authorization, and Restriction of Chemicals) imposes further limitations on hazardous substances in consumer products, including

33 Consumer Product Safety Commission (CPSC). (2021). Lead Content in Children's Products.
34 European Chemicals Agency (ECHA). (2020). REACH Regulation and Chemical Safety.

toys.[1] Phthalates like DEHP, DBP, and BBP are also restricted under REACH to no more than 0.1% by weight in any plastic component.[1]

3.1.2. United States (US)

In the United States, the Consumer Product Safety Improvement Act (CPSIA) of 2008 regulates chemical content in children's products.[35]

Table 2: US Limits for Chemicals in Toys (CPSIA & ASTM F963)

Substance	Maximum Allowable Limit
Lead (total content)	100 ppm (parts per million)
Lead in surface coatings	90 ppm
Phthalates (DEHP, DBP, BBP)	0.1% by weight
Cadmium, Chromium, Mercury, Arsenic, Antimony, Selenium, Barium	Regulated under ASTM F963 (migration limits vary per element)

Toys must conform to the ASTM F963 safety standard, which includes limits on eight heavy metals and additional mechanical and flammability testing. Third-party testing and certification are mandatory before toys enter the US market.

3.1.3. ISO Standards

The ISO 8124 international standard outlines safety requirements and testing procedures for mechanical, physical, flammability, and chemical properties of toys.[36]

Table 3: ISO 8124-3 Migration Limits for Certain Elements

Substance	Migration Limit (mg/kg)
Lead	90 mg/kg
Cadmium	75 mg/kg
Chromium VI	0.2 mg/kg
Mercury	60 mg/kg

These standards are widely used for international trade and harmonization of toy safety.

35 ASTM F963-17. Standard Consumer Safety Specification for Toy Safety.
36 ISO 8124. International Standards for Safety of Toys.

3.1.4. World Health Organization (WHO)

The World Health Organization (WHO) plays an essential role in advising on chemical safety and children's environmental health. Although WHO does not issue legally binding standards specifically for toy safety, it provides global health-based guidance that informs national and international regulatory frameworks.[37]

WHO has emphasized that:

- Children are not little adults; they absorb and retain more toxic substances than adults and are more vulnerable to environmental toxins due to their developing systems.
- No safe level of lead exposure exists for children. Lead can cause irreversible neurological and behavioral damage even at very low exposure levels.
- WHO promotes the adoption of chemical risk reduction strategies, chemical monitoring systems, and safer product manufacturing practices to protect children from exposure to harmful substances.

The WHO's Global Initiative on Children's Environmental Health Indicators (CEHI) and its 2010 report on Children's Environmental Health stress the need for rigorous controls over consumer products, including toys, that may contain toxic chemicals.[38]

3.2. Bangladesh's Regulations and Implementation Gaps

3.2.1. National Standards and Oversight

In Bangladesh, the Bangladesh Standards and Testing Institution (BSTI) is responsible for setting and enforcing product standards. Although a voluntary toy safety standard has been drafted under the BSTI Act (2018), no mandatory regulations or enforceable limits currently exist for heavy metals or other chemical content in children's toys.[39]

BSTI inspects over 299 product categories; however, toys are not included in mandatory market surveillance.[40] Consequently, chemical safety testing is rarely conducted, and regulatory control remains weak.

3.2.2. Regulatory and Enforcement Challenges

Despite growing evidence of health hazards, Bangladesh faces several structural and operational challenges in regulating toy safety:

37 World Health Organization (WHO). (2010). Children's Environmental Health.
38 QIMA. (2023). Global Guide to Toy Safety and Lead Compliance.
39 Bangladesh Standards and Testing Institution (BSTI). (2018). BSTI Act & Policy Framework.
40 Environment and Social Development Organization (ESDO) & IPEN. (2013). Toxic Toy Study in Dhaka Markets.

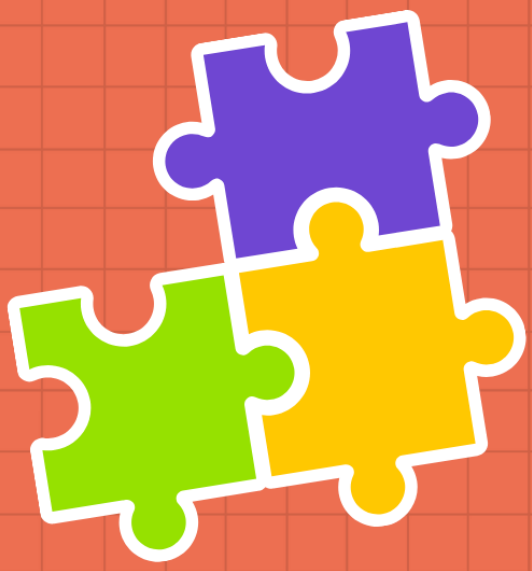
- **Absence of Legally Binding Standards:** As of 2025, no legally enforced chemical safety standards for toys exist in Bangladesh. This regulatory vacuum allows unsafe toys to circulate freely.41
- **Weak Market Surveillance:** BSTI's oversight does not mandate toy inspections. A 2022 ESDO study showed that over 78% of toys sampled from Dhaka's informal markets contained one or more heavy metals above international safety limits.[8]
- **Lack of Accredited Testing Facilities:** With only a few certified laboratories capable of testing for heavy metal contamination in consumer products, routine safety checks are virtually non-existent.[9]
- **Ineffective Import Control:** Toy imports, especially from China and other low-cost manufacturers, are rarely subjected to chemical screening. In 2023, over 60% of toy imports came without product traceability or safety labeling.42
- **Public Unawareness:** There is limited awareness among consumers regarding chemical risks in toys. Most parents rely on price and aesthetics, not safety credentials, when purchasing toys.43
- **No Recall Mechanism:** Bangladesh lacks a national recall protocol for hazardous toys, meaning contaminated products remain in circulation even after hazards are known.

Without urgent reforms, these gaps will continue to place millions of children at risk of toxic exposure.44

3.2.3. Regional Comparisons and Cross-Border Lessons

Neighboring India has adopted BIS Certification for toy safety, making third-party testing mandatory for both local and imported toys.45 This presents a regulatory model that Bangladesh could adapt to fill its current gaps.

41 TBS News. (2024). Lack of Toy Safety Laws in Bangladesh Raises Alarm.
42 IPEN (2021). Toxic Toy Imports in South Asia: Regulatory Gaps and Consumer Safety.
43 Bangladesh Post (2024). Keep Our Kids Safe from Toxic Toys.
44 Dhaka Tribune. (2024). Dangerous Toys Abound in Dhaka Markets.
45 UNICEF South Asia. (2021). Children's Environmental Health in the Region.



Chapter Four

Materials and Methods

4. Materials and Methods: Evaluating Toxic Elements in Toys

4.1. Study Design and Objectives

This study is designed as a multi-dimensional investigative assessment of hazardous heavy metals, particularly **lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), antimony (Sb),** and other toxic elements, in plastic toys targeted at children aged 0–5 years. This age group is known for frequent hand-to-mouth behavior, which significantly increases their exposure risk.

The investigation combines market-based sampling, advanced screening using **X-Ray Fluorescence (XRF)** technology, and a comparative risk analysis using international regulatory benchmarks. It also reflects on the regulatory vacuum in Bangladesh regarding toy safety and calls for urgent policy interventions based on scientific evidence.

4.2. Sampling Framework

4.2.1 Sampling Objective

To ensure a representative and risk-sensitive selection of children's plastic toys, the sampling strategy was crafted to capture:

- Products with high market circulation
- Brightly pigmented toys are likely to contain hazardous dyes
- Age-specific toys meant for mouthing and tactile interaction
- Products from a mix of local and international manufacturers

4.2.2 Sampling Location and Justification

The primary sampling zone was **Chawkbazar, Old Dhaka**, the largest wholesale and semi-retail toy distribution hub in Bangladesh. Toys purchased here are subsequently supplied to markets across the country. This makes it the most strategic location for capturing a national market footprint.

Additional locations mentioned in prior studies (e.g., Bashundhara City, New Market, Orchid Plaza) were also considered for supplementary data validation.

Study Methodology

4.2.3 Product Selection Criteria

- **Toy Type**: Rigid/hard plastic toys (known to contain plasticizers and pigment stabilizers)
- **Color Bias**: Priority to bright colors- **red, yellow, orange**, based on previous findings of higher metal concentrations in these hues
- **Age Range**: All toys selected were either labeled or visibly designed for children aged **0–5 years**
- **Packaging Condition**: Only factory-sealed or visibly intact toys were selected to prevent contamination
- **Manufacturer Traceability:**
    - 18 local Bangladeshi manufacturers (3–5 samples each)
    - 2 Chinese manufacturers (3 samples each)
    - 5 unbranded/unlabeled samples (1 sample each)

4.2.4 Total Sample Size

A total of **70 toy samples** were collected for screening. This sample size was considered adequate for:

- Identifying high-risk manufacturer groups
- Conducting statistical comparisons between the countries of origin
- Establishing trends in color- or material-based metal concentrations

4.2.5 Sample Documentation & Handling

For every sample collected:

- Product name and manufacturer were noted
- Color, shape, material, and packaging features were recorded
- Photos were taken from multiple angles
- Samples were labeled with unique IDs using masking tape on the surface of the toys and stored.

4.3. Analytical Technique: X-Ray Fluorescence (XRF) Spectroscopy

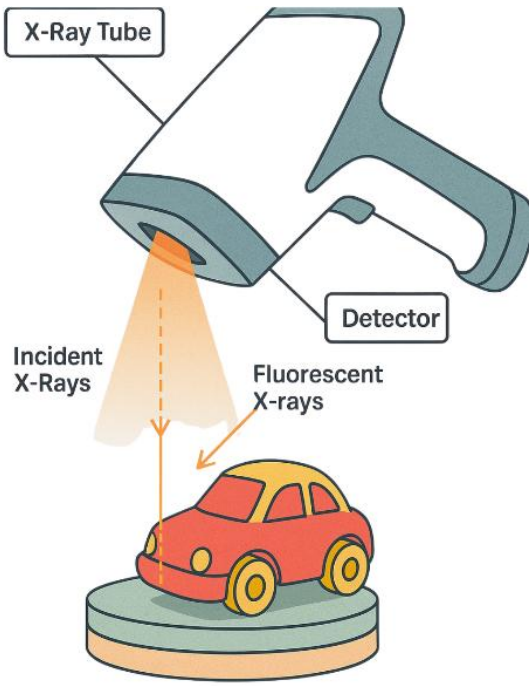
4.3.1 Instrument Details

X-Ray Fluorescence (XRF) is a non-destructive analytical technique used to determine the elemental composition of materials. It is widely employed in environmental testing, consumer product safety, and quality control for detecting heavy metals in solids, including plastic toys.

Working Principle

When a material is exposed to a source of high-energy primary X-rays, the atoms within the material may become excited. This happens when the energy of the incoming X-ray photons is sufficient to eject tightly bound inner shell electrons (usually from

the K or L shell). This creates an unstable electron configuration, prompting an electron from a higher energy level (e.g., L or M shell) to drop down and fill the vacancy[46].



During this transition, the atom emits **secondary (fluorescent) X-ray radiation** that is characteristic of the element from which it originated. Each element emits X-rays at a unique energy level, allowing for precise identification and quantification.

The XRF analyzer detects these emitted energies and calculates: **Qualitative data** (which elements are present) and **Quantitative data** (how much of each element is present, typically in parts per million or ppm)[47].

Advantages in Toy Testing

- **Non-destructive**: Samples remain intact after testing
- **Rapid and portable**: Real-time results within seconds
- **Multi-element detection**: Simultaneously screens for multiple metals (e.g., Pb, Cd, Cr, Hg, As)
- **No reagents required**: Environmentally safer than wet chemistry

In this investigation, the **Olympus Vanta M-series handheld XRF** was used under the **plastic/polymer testing mode**. The technique enabled the detection of toxic metals embedded in toy surfaces without damaging the samples, aligning with UNEP and WHO screening protocols for hazardous materials in consumer products.

4.3.2 Why XRF?

XRF is a non-destructive, real-time elemental analysis technique used widely for consumer product testing. It provides surface concentration of metals in parts per million (ppm) without altering the sample. This enables follow-up confirmatory testing (e.g., wet digestion or ICP-MS) on the same unit, if needed.

Benefits:

- Fast (≤1 minute per toy)
- Portable and user-friendly

46 Pichtel, J. (2014). Waste management practices: Municipal, hazardous, and industrial (2nd ed.). CRC Press. https://api.pageplace.de/preview/DT0400.9781482273380_A38906336/preview-9781482273380_A38906336.pdf

47 American Society for Testing and Materials. (2015). ASTM F2617–15: Standard test method for identification and quantification of chromium, bromine, cadmium, mercury, and lead in polymeric material using energy dispersive X-ray spectrometry (Reapproved 2023).

- Field-deployable
- Avoids chemical reagents and waste

4.3.3 Sample Preparation

No chemical cleaning or abrasion was performed. Each toy surface was gently dusted with a clean lint-free cloth. This method preserved surface contaminants that children might also ingest via mouthing behavior allowing for realistic exposure assessment.

4.3.4 Measurement Protocol

- Before analysis, the XRF analyzer was calibrated using reference standards with known lead concentrations to ensure accurate measurements
- Each sample was tested on three different non-overlapping areas
- Readings were averaged to improve accuracy and reduce local pigment variability
- Each scan was conducted for **30-40 seconds**
- The instrument was set to "Polymer/Plastic" mode

4.3.5 Calibration and Quality Control

- The XRF analyzer was turned on, and the necessary warm-up time was allowed as specified by the manufacturer.
- The appropriate calibration mode for the material being tested (plastic) was selected.
- Duplicates: 10% of total samples were reanalyzed for reproducibility
- The reference standards were re-analyzed periodically to confirm that the XRF analyzer maintained accuracy throughout the testing.

4.4. Evaluation Criteria and Standards

4.4.1 International Reference Limits

Metal	EU Toy Safety (EN 71-3)	US CPSIA	China GB 6675	Bangladesh Status
Lead (Pb)	13.5 ppm (scraped)	100 ppm (total)	90 ppm	Not defined
Cadmium (Cd)	1.9 ppm	75 ppm	50 ppm	Not defined
Chromium (Cr VI)	0.053 ppm	Not defined	60 ppm (total Cr)	Not defined
Mercury (Hg)	7.5 ppm	60 ppm	25 ppm	Not defined
Arsenic (As)	0.2 ppm (indicative)	25 ppm	25 ppm	Not defined

Note: Bangladesh currently lacks **formally endorsed safety limits** for toxic elements in toys. However, ESDO continues to engage with BSTI for the adoption of minimum standards.

4.4.2 Risk Classification

- **Green (Compliant)**: < 50% of strictest standard
- **Yellow (Borderline)**: 50–100% of limit
- **Red (High-risk/Non-compliant)**: > 100% of limit

Color-coded matrices are used to visually flag samples that pose acute or chronic toxicity risks.

4.5. Data Analysis

All raw XRF data were exported and recorded, then compiled into a secure analysis sheet for processing in **Microsoft Excel**. The following analyses were performed:

- **Descriptive Statistics**: Mean, median, min-max, and SD for each element
- **Frequency Distribution**: % of samples exceeding permissible limits
- **Color Correlation**: Bright colors vs. metal burden trends
- **Manufacturer Analysis**: Grouping exceedances by producer identity
- **Country-of-Origin Mapping**: Risk categorization by source country
- **Comparative Analysis**: Cross-matching current data with 2013 and 2024 ESDO findings
- **Preliminary Risk Index**: Based on estimated daily exposure and hazard quotient (HQ)

4.6. Ethical Considerations and Waste Management

- No human subjects involved; ethical review not required
- Toys tested were either retained for advocacy/display or stored as evidence
- Damaged or high-metal toys will be handed over to certified hazardous waste disposal agencies following protocols
- Staff involved used gloves and masks during sample collection and testing

4.7. Study Limitations

Limitation	Mitigation
Surface-level analysis (XRF) does not confirm total migratable content	Follow-up confirmation will be done via ICP-MS planned for high-risk samples
Sampling bias toward high-risk colors (red, yellow, orange)	Study framed as risk-oriented, not a prevalence survey
Lack of national regulatory benchmark	International benchmarks from the EU/US are used as a proxy
Small sample from Chinese/unbranded toys	Supplemented with prior studies and visual labeling checks

4.8. Strengths and Innovations

- Most recent dataset (2024-2025) on toxic toys in Bangladesh.
- First study to integrate manufacturer-specific analysis.
- XRF protocol aligned with WHO and UNEP recommendations.
- Supports a growing advocacy movement for BSTI-backed toy safety standards.
- Directly links findings to SDGs: 3 (Health), 12 (Sustainable Consumption), 16 (Regulatory Institutions).

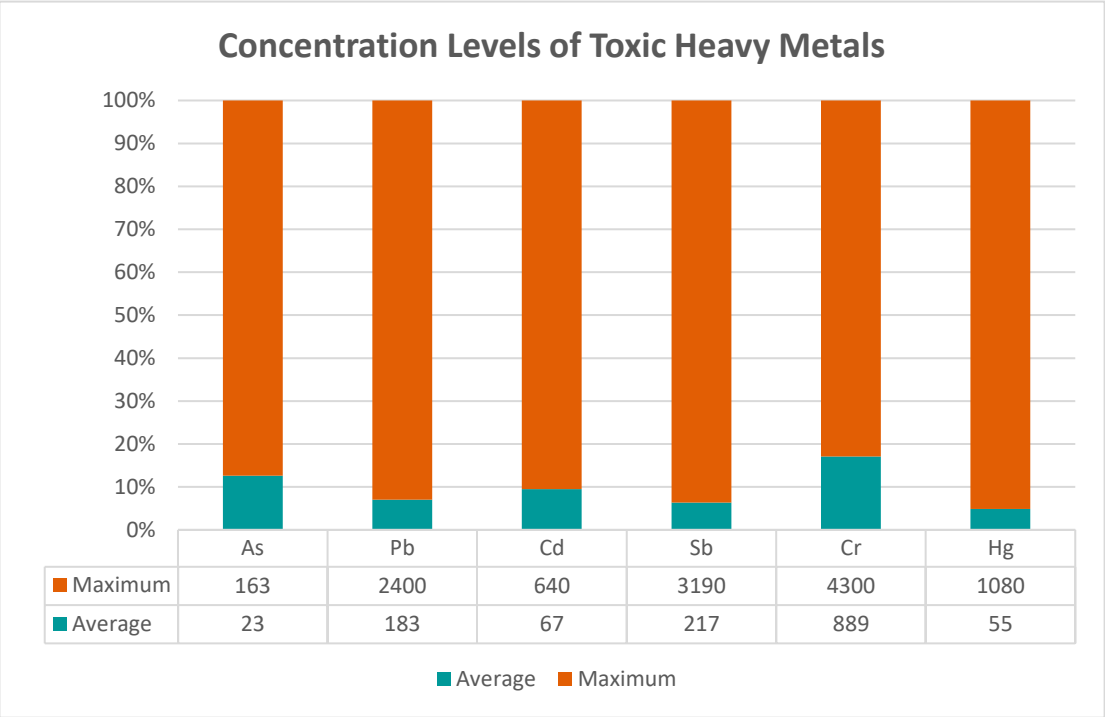
Chapter Five

Results and Key Findings

5. Results and Key Findings: Heavy Metals Rampant in Children's Toys

A total of 70+ children's plastic toys were analyzed using X-ray fluorescence (XRF) screening, revealing widespread contamination with hazardous heavy metals, many at levels significantly above internationally accepted safety limits. The study uncovered systemic health threats posed by toys available in the Bangladeshi market, largely driven by the absence of regulatory enforcement and low-quality local manufacturing practices.

5.1. Alarming Concentration Levels of Toxic Heavy Metals



The analysis of heavy metal concentrations in toys revealed not only frequent contamination but also alarming intensity in the levels of toxic substances detected. In many cases, the measured concentrations far surpassed internationally accepted safety limits.

For instance, **chromium**, a known allergen and potential carcinogen, was found at an average level of **889 ppm**, with the highest reading reaching **4300 ppm**, more than **70 times the permissible limit** (60 ppm). **Lead**, a potent neurotoxin linked to irreversible cognitive damage, averaged **183 ppm** across the toys but peaked at a staggering **2400 ppm**, which is **26 times** higher than the limit set by both EU and US safety guidelines.

Similarly, **antimony**, commonly used as a flame retardant but associated with respiratory and dermal toxicity, reached an extreme **3190 ppm** in one sample. **Cadmium** and **mercury**, both of

which are highly toxic even in trace amounts and known to accumulate in body tissues, were also present at dangerously high levels up to **640 ppm** and **1080 ppm**, respectively. **Arsenic**, with its well-established links to developmental toxicity, was found at levels up to **163 ppm**, nearly **7 times** the regulatory threshold.

These data points underscore a **disturbing pattern of systemic toxic exposure**. Far from isolated instances, the prevalence of such high concentrations across multiple metals strongly suggests the routine use of **hazardous and industrial-grade chemicals** in the production of children's toys. Given children's heightened vulnerability — including faster absorption rates and increased hand-to-mouth behavior — these levels present a **critical public health emergency**. The potential for cumulative, long-term damage to children's developing brains, organs, and immune systems cannot be overstated.

5.2. Widespread Violations of International Safety Limits

Metal	No. of Toys Exceeding Limit	% of Total Toys	Regulatory Limit (ppm)	Maximum Detected (ppm)	Example (Label No)
Chromium (Cr)	48	68.6%	60	4300	Red Fire Truck (TS051, China)
Antimony (Sb)	47	67.1%	60	3190	Orange Car (TS001, BD)
Lead (Pb)	27	38.6%	90	2350	Blue Car (TS003, BD)
Arsenic (As)	23	32.9%	25	163	Orange Car (TS001, BD)
Cadmium (Cd)	20	28.6%	75	640	Burger Set Pizza (TS027, BD)
Mercury (Hg)	16	22.9%	60	1080	Blue Car (TS003, BD)

The above table summarizes the frequency and severity of safety limit violatio heavy metals. Chromium and antimony emerged as the most prevalent contamin legal thresholds in nearly 70% of all tested toys. These elements are commonly used in plastic dyes, stabilizers, and flame retardants, indicating the unregulated use of industrial-grade materials in children's products. Lead, arsenic, and cadmium, known neurotoxins and carcinogens, were also present at dangerous levels in one-third or more of the toys. Mercury, while less frequently detected, showed extremely high concentrations when present. The examples listed in the table demonstrate real cases of toys exceeding the limits by 10 to 70 times, posing severe health risks, especially to infants and toddlers.

5.3. Highest-Risk Toys Identified

A ranking of the top 10 most contaminated toys revealed that many items contained **multiple toxic metals**, often exceeding limits by tens of times. The worst offender, **TS003 (Blue Car by Aman Toy Garden)**, exceeded safety limits for 5 different metals, including:

- **Lead at 2350 ppm** (26× the legal limit),
- **Chromium at 1400 ppm** (23×),
- **Mercury at 1080 ppm** (18×), and
- **Antimony at 1350 ppm** (22×).

Toy (Label No)	Manufacturer	Country	Total Metals Exceeding Limit	Worst Violation
TS003 - Blue Car	Aman Toy Garden	Bangladesh	5	Pb: 26×
TS051 - Red Fire Truck	Ao Hai	China	3	Cr: 71×
TS027 - Burger Set	Shahjalal Toys Gallery	Bangladesh	3	Cd: 8.5×
TS019 - Police Car	Karim Toys	Bangladesh	3	Pb: 27×
TS024 - Sniper Car	Khokon Plastick Products	Bangladesh	3	Cr: 43×

The top five most contaminated toys exhibited multiple simultaneous violations. These toys not only exceeded permissible limits but did so across three to five different metals. The **Blue Car (TS003)** by Aman Toy Garden had the most severe case, with extremely high levels of lead, chromium, mercury, antimony, and arsenic. The **Red Fire Truck (TS051)** from China demonstrated the single most extreme violation, with chromium levels exceeding the EU limit by over 70 times. These findings highlight the dangerous cumulative toxicity of multiple contaminants, which, when combined in a single product, can drastically elevate the risk of developmental, neurological, and immunological damage in children.

5.4. Manufacturer-Wise Violation Patterns

Manufacturer	Toys Tested	Toys Exceeding Limits	% Exceedance	Top Heavy Metals	Worst Toy (Example)
Aman Toy Garden (BD)	4	4	100%	Pb, Sb, Cr	TS003 (Pb: 2350 ppm)
Khokon Plastick Products (BD)	4	4	100%	Cr, Sb, Cd	TS024 (Cr: 2600 ppm)
Shahjalal Toys Gallery (BD)	4	4	100%	Cd, Cr	TS027 (Cd: 640 ppm)
Karim Toys (BD)	4	3	75%	Pb, Cr	TS019 (Pb: 2400 ppm)
Zihan Plastic Industry (BD)	4	3	75%	Pb, Cr	TS007 (Pb: 650 ppm)
Unnamed (BD)	6	5	83.3%	Cr, Pb, Hg	TS060 (Cr: 2300 ppm)
Ao Hai (China)	4	2	50%	Cr, Pb	TS051 (Cr: 4300 ppm)

Figure: The Most Toxic Toys Produced by Different Manufacturers

Several Bangladeshi manufacturers had a 100% exceedance rate, confirming a lack of compliance with international safety standards and poor regulatory enforcement within the domestic industry.

This manufacturer-level analysis reveals that the most toxic toys are overwhelmingly produced by Bangladeshi manufacturers, with 100% exceedance rates in brands such as Aman Toy

Garden, Khokon Plastick Products, and Shahjalal Toys Gallery. These manufacturers repeatedly produced toys that violated multiple heavy metal thresholds, often severely. The issue appears systemic, pointing to the use of contaminated or substandard raw materials, as well as a complete absence of quality control or mandatory testing protocols. While imported toys (such as those from Ao Hai, China) were also problematic, locally manufactured toys accounted for the majority of high-risk cases.

5.5 Chlorine and Bromine in Toys: Hidden Toxicity Behind PVC and Flame Retardants

5.5.1. Summary of High Cl/Br Findings

Testing of 70 toys revealed widespread contamination with chlorine and bromine, both of which are indicative of hazardous materials like PVC plastic and brominated flame retardants (BFRs)**.** These substances pose potential risks to child health and the environment and remain under-regulated in the toy manufacturing industry.

Parameter	Cl (ppm)	Br (ppm)	Notes
Max Detected	10,000	3,900	Both levels are alarmingly high.
Toys > 1,000 ppm	15/70 (21.4%)	12/70 (17.1%)	Indicates widespread toxic material use.
Common Sources	PVC plastic, flame retardants	Brominated flame retardants (BFRs)	Known for endocrine and thyroid disruption.

5.5.2. Top 5 Toys with Extreme Cl/Br Levels

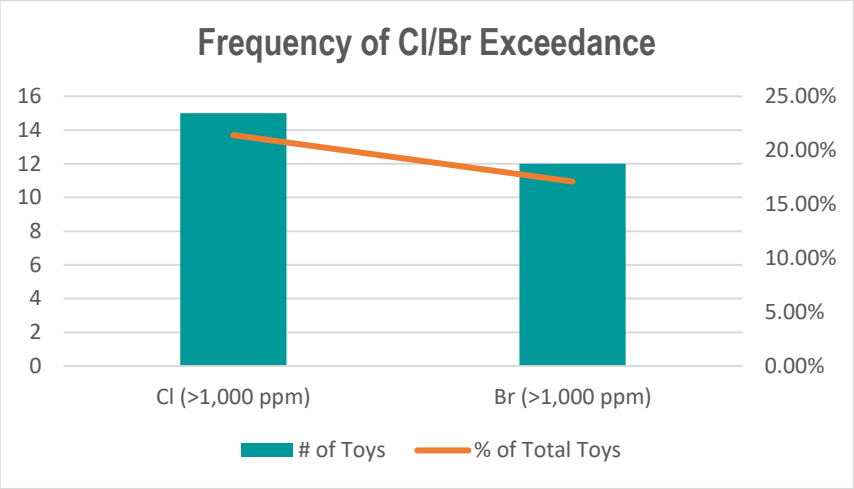
The following toys exhibit the highest recorded levels of chlorine and bromine. Their material composition likely includes PVC and BFRs, which are associated with long-term health effects, especially in children.

Label No	Toy Description	Manufacturer	Cl (ppm)	Br (ppm)	Potential Source
TS014	Puzzles (Air Bus)	Kader Plastic Products	10,000	48	PVC plastic (chlorine-based)
TS060	Mickey Mouse Jhuna (Pink)	Unnamed (Bangladesh)	10,000	3900	BFRs in colored PVC plastics
TS017	Barbie Doll Pink	Nazrul Toy Industry	10,000	14	PVC body/accessories

TS058	Mickey Mouse Jhuna (Blue)	Unnamed (Bangladesh)	10,000	276	BFRs + PVC
TS019	Police Car Set	Karim Toys	10,000	322	Flame-retardant surface coatings

Chlorine at 10,000 ppm (10% of toy weight) strongly suggests PVC use, often associated with banned additives like phthalates (e.g., DEHP, DBP).

Toys with Br >1,000 ppm may contain BFRs, which are linked to neurodevelopmental disorders and thyroid disruption in children.



5.5.3. Manufacturer Accountability

Manufacturer (Worst Offenders)	Toys with Cl/Br >1,000 ppm	Likely Culprit
Unnamed (Bangladesh)	5 (e.g., TS058, TS060)	Cheap PVC and BFR-laden colored plastics
Kader Plastic Products	1 (TS014)	Industrial PVC reuse with poor oversight
Nazrul Toy Industry	2 (TS016, TS017)	Inadequate material sourcing or testing

These manufacturers are consistently associated with high levels of Cl and Br, indicating systemic use of harmful substances.

Chapter Six

Hidden Toxicity

The Role of Chlorine and Bromine in Children's Toys

6. Hidden Toxicity: The Role of Chlorine and Bromine in Children's Toys

Despite their bright colors and playful forms, many children's plastic toys in Bangladesh conceal hazardous chemical components that pose long-term health and environmental risks. Among the most insidious of these are **chlorine (Cl)** and **bromine (Br)** chemical elements that signal the likely presence of **Polyvinyl Chloride (PVC)** and **Brominated Flame Retardants (BFRs)**. These substances, frequently found in low-cost and recycled plastic toys, are well-documented for their links to endocrine disruption, thyroid dysfunction, and developmental toxicity.

6.1 Polyvinyl Chloride (PVC): A Primary Source of Chlorine

PVC, one of the most commonly used plastics in the toy industry, can contain up to **57% chlorine by weight**. The detection of **chlorine levels as high as 10,000 ppm** (or 1% of toy weight) in multiple samples from this study strongly confirms the use of PVC in these products.

PVC is prized for its flexibility, gloss, and low production cost. It is commonly used in:

- **Soft and squeezable toy parts**, such as doll bodies and puzzle coatings
- **Brightly colored and flexible molded figurines**, such as rubber animals and rattles

However, PVC is rarely used in its pure form. To achieve the desired texture and durability, it is often mixed with **toxic additives** such as:

- **Phthalates** - used as plasticizers, linked to reproductive toxicity
- **Lead (Pb)** - often present in pigments, affects neurological development
- **Cadmium (Cd)** - used as a stabilizer, associated with kidney damage and cancer

Observation from this study revealed that **10 out of 12 toys** with extreme chlorine levels also **exceeded international safety limits** for at least one other toxic heavy metal, such as **Pb, Cd, or Cr**, suggesting that PVC-based toys tend to carry a cocktail of chemical threats to children's health[48] [49].

48 European Chemicals Agency (ECHA), Annex XV Restriction Report: Proposal for a Restriction of Four Phthalates (DEHP, DBP, BBP, and DIBP), 2017.
49 World Health Organization (WHO), Children's Health and the Environment: A Global Perspective, 2010.

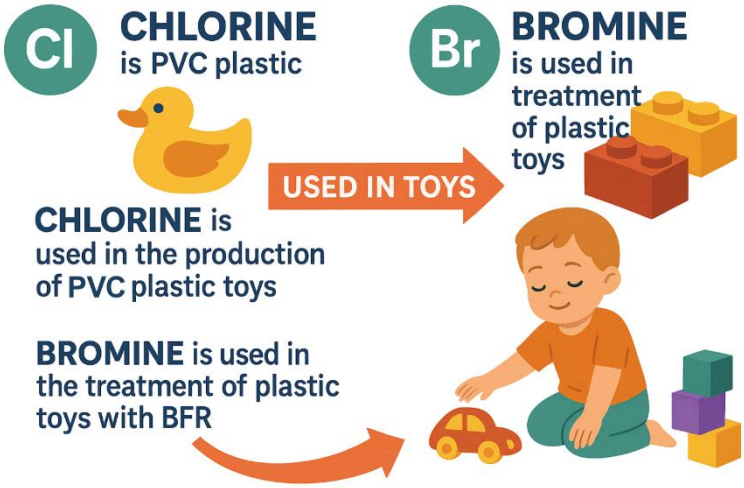
6.2 Brominated Flame Retardants (BFRs): A Source of Bromine in Toys

Another group of concerning chemicals in children's toys are **brominated flame retardants (BFRs)**. These compounds are used to reduce flammability in plastic products, particularly in those intended for international markets. In this study, **bromine concentrations reached up to 3,900 ppm** in certain toys, strongly indicating the use of BFRs such as:

- **Tetrabromobisphenol A (TBBPA)**
- **PentaBDE** (Pentabromodiphenyl ether)
- **DecaBDE** (Decabromodiphenyl ether)

BFRs are typically added to:

- **Brightly colored toys**, especially in red, orange, and pink shades
- **Soft plastic items** like **"jhuna" rattles**, which are commonly sold in Bangladesh's informal toy markets



Their presence in toys is particularly troubling because **BFRs are not chemically bonded** to the plastic matrix. This means they can **leach out over time**, especially when toys are mouthed, chewed, or exposed to heat, leading to chronic, low-dose exposure in children50 51.

This study identified toys such as **TS060 and TS058**, which not only had extremely high Br levels but also showed **intense coloration and soft plastic textures,** both common indicators of flame retardant-treated materials.

50 Birnbaum, L.S. and Staskal, D.F., Brominated Flame Retardants: Cause for Concern?, Environmental Health Perspectives, 2004.
51 UNEP, Stockholm Convention on Persistent Organic Pollutants – BFR Review, 2016.

6.3 Contaminated Recycled Plastics: A Shared Source of Chlorine and Bromine

The **common denominator** behind the presence of both chlorine and bromine is the **widespread use of contaminated recycled plastics** in low-cost toy manufacturing. These plastics are often sourced from:

- **Electronic waste (e-waste)**, which contains high levels of BFRs
- **Discarded industrial PVC waste**, which retains residual phthalates and heavy metals

Such materials are inexpensive and widely available in Bangladesh's informal recycling sector. However, they carry **"legacy contaminants"**- chemicals banned or restricted in new products but still present in recycled materials.

Several toys analyzed in this study, particularly those from **unnamed or low-cost Bangladeshi manufacturers**, had **both Cl and Br levels exceeding 1,000 ppm**, strongly suggesting **the use of low-quality, contaminated inputs**[52] [53].

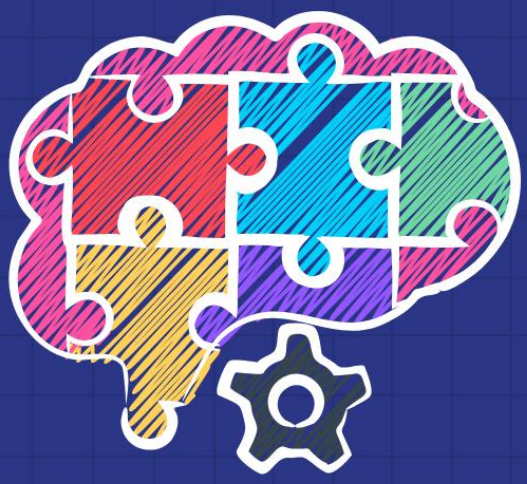
6.4 Why This Matters: Hidden Threats in Everyday Play

The presence of high levels of **chlorine and bromine** in children's toys indicates more than material choice, it points to **chemical hazard accumulation**. These substances are **proxies for deeper toxicity**, revealing the likely inclusion of additional hazardous additives.

Substance	Primary Material Source	Associated Toxic Additives	Health Risks
Chlorine (Cl)	PVC plastic	Lead (Pb), Cadmium (Cd), Phthalates	Endocrine disruption, dioxin formation, cancer risk
Bromine (Br)	BFR-treated plastic	TBBPA, PentaBDE, DecaBDE	Thyroid disruption, neurodevelopmental toxicity

In short, toys with **elevated chlorine or bromine levels** are almost certainly **not safe**, even if they appear visually undamaged or physically sturdy. These chemical threats are **invisible**, **long-lasting**, and **cumulatively harmful**, especially in the hands of the most vulnerable: **young children**[54] [55].

52 IPEN, Toxic Loophole: Recycling Hazardous Waste into New Products, 2015.
53 ESDO & BAN Toxics, Toxic Toys in Bangladesh: 2024 Study Report, Dhaka.
54 Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profiles for Selected Flame Retardants, 2018.
55 United Nations Environment Programme (UNEP), Children's Environmental Health: Chemical Risks and Policy Gaps, 2020.



Chapter Seven

Health Impacts of Heavy Metals in Plastic Toys

7. Health Impacts of Heavy Metals in Plastic Toys

Toys are often considered safe, colorful tools for learning and play. However, studies from around the world, including Bangladesh, have found that plastic toys, especially brightly colored ones, can contain hazardous levels of heavy metals like lead, cadmium, mercury, chromium, and arsenic. These metals are used in pigments, stabilizers, or as part of recycled plastic inputs. Since children (especially under 5 years old) frequently put toys in their mouths or handle them before eating, they are at extremely high risk of ingesting or absorbing these toxicants, even at low doses.

Unlike adults, children's bodies are still developing. Organs such as the brain, kidneys, and immune system are more vulnerable to damage. Exposure during critical developmental windows can lead to lifelong health consequences, some of which are irreversible. The impacts are most dangerous in three key areas: neurological (brain and nerves), renal (kidneys), and carcinogenic (cancer-causing)**.**

The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have consistently warned that no level of lead, mercury, or cadmium is safe for children, and exposure can result in irreversible damage to the nervous system, kidneys, and even trigger long-term cancer risk.

7.1. Lead (Pb)

Neurological Effects

Lead is one of the most potent neurotoxins for children. It crosses the blood-brain barrier and accumulates in the frontal cortex, hippocampus, and cerebellum, regions critical for cognition, memory, and motor function. Lead interferes with neurotransmitter release, dendritic growth, and calcium signaling in neurons56. For instance, in 2007, the U.S. Consumer Product Safety Commission recalled over 1.5 million Mattel toys made in China after they were found to contain dangerous levels of lead paint[57].

- **Cognitive Deficits**: Research shows that **every 10 µg/dL increase in blood lead levels can result in a 4-7 point drop in IQ**[58]. Lead exposure is directly correlated with reduced school performance, attention disorders, and lower academic achievement.

56 Centers for Disease Control and Prevention. (n.d.). Lead exposure symptoms and complications | Childhood lead poisoning prevention. U.S. Department of Health & Human Services. https://www.cdc.gov/nceh/lead/prevention/health-effects.htm
57 Barboza, D. (2007, August 2). Millions of toys are recalled by Mattel. The New York Times. https://www.nytimes.com/2007/08/02/business/worldbusiness/02iht-toys.4.6961912.html
58 Bellinger, D. C. (2013). Prenatal exposures to environmental chemicals and children's neurodevelopment: An update. Safety and Health at Work, 4(1), 1–11. https://doi.org/10.5491/SHAW.2013.4.1.1

- **Behavioral Disorders**: Long-term exposure is associated with impulsivity, aggression, and delinquent behavior in adolescence. In extreme cases, lead poisoning leads to encephalopathy, which manifests as seizures, unconsciousness, and potentially coma or death.

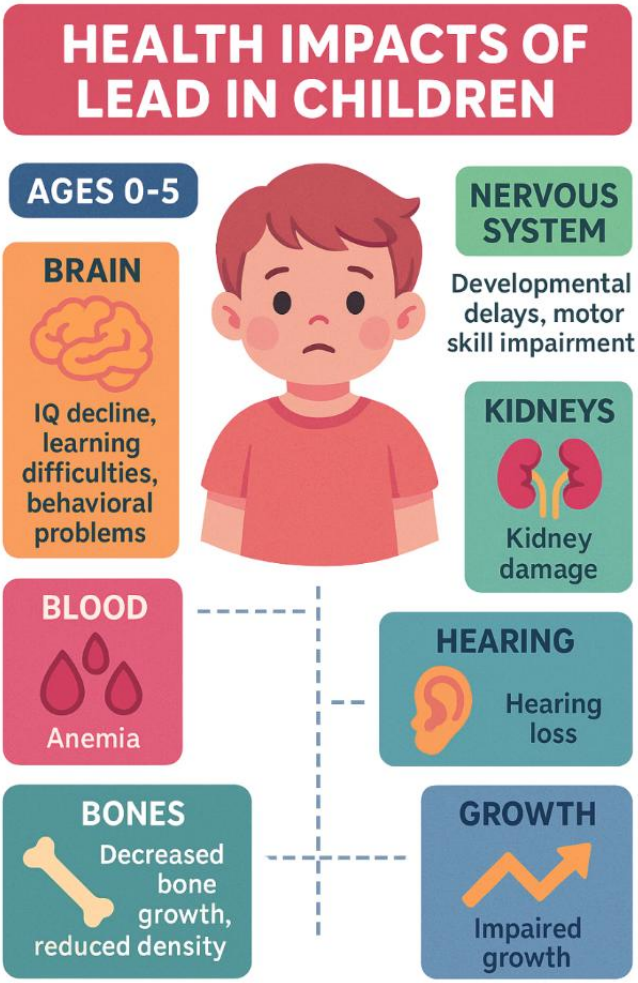
Renal Effects

Lead is reabsorbed in the proximal tubules of the kidney where it induces oxidative stress, mitochondrial dysfunction, and eventually tubular atrophy[59].

- **Chronic Kidney Disease (CKD)**: Long-term exposure leads to interstitial fibrosis and glomerular sclerosis, reducing the kidneys' ability to filter blood.
- **Early Signs**: Include proteinuria, hyperuricemia, and rising blood pressure in children.

Carcinogenicity

IARC has classified inorganic lead compounds as Group 2A carcinogens, meaning they are probably carcinogenic to humans[60]. Studies have shown an increased risk of lung, bladder, and stomach cancers among workers exposed to lead in smelting and battery industries.



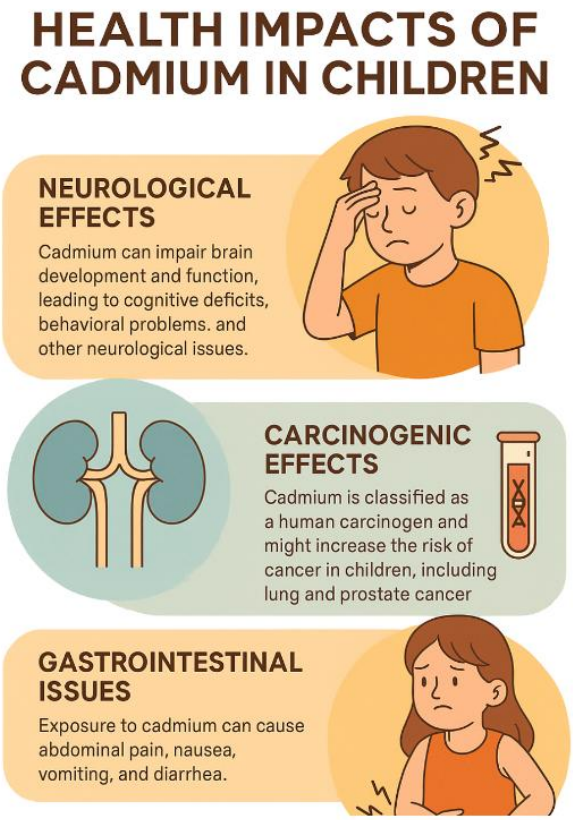
7.2. Cadmium (Cd)

Neurological Effects

Cadmium exposure may result in disruption of neurotransmission and oxidative stress in neural tissues. Chronic exposure has been shown to impair the sense of smell by damaging olfactory neurons. Several population studies link cadmium exposures to slower reaction times, attention

59 National Kidney Foundation. (n.d.). Lead exposure and kidney function. https://www.kidney.org/kidney-topics/lead-exposure-and-kidney-function#:~:text=Lead%2Drelated%20damage%20to%20the,have%20their%20lead%20levels%20checked
60 European Commission. (n.d.). IARC classification. Health and Scientific Committees. https://ec.europa.eu/health/scientific_committees/opinions_layman/en/tooth-whiteners/glossary/ghi/iarc-classification.htm

deficits, and impaired cognitive flexibility. Cadmium can mimic calcium ions and interfere with normal neural signaling, and also impair the function of astrocytes.



Renal Effects

Cadmium is well-documented as a nephrotoxic agent, accumulating in the kidneys for decades[61].

- **Proximal Tubule Injury**: Causes increased urinary excretion of low-molecular-weight proteins like β-2 microglobulin and retinol-binding protein.
- **Bone Demineralization**: Cadmium exposure also results in **calcium loss through the urine**, leading to osteomalacia and bone pain.
- **Itai-Itai Disease**: First identified in Japan, this condition resulted from long-term cadmium exposure and involved **severe kidney damage and skeletal deformities**[62].

Carcinogenicity

Cadmium is classified as a **Group 1 carcinogen** by IARC[63]. It is known to cause lung cancer, particularly via inhalation, and is suspected in renal and prostate cancers, acting by inducing DNA strand breaks, oxidative stress, and inhibiting DNA repair enzymes.

7.3. Mercury (Hg)

Neurological Effects

Mercury exists in multiple forms: elemental, inorganic, and organic (methylmercury). Organic forms, especially **methylmercury**, are the most neurotoxic[64]. Mercury crosses the placenta and blood-brain barrier, causing irreversible brain damage during fetal development. Children

61 World Health Organization. (2019). Lead poisoning and health (WHO/CED/PHE/EPE/19.4.3). https://www.who.int/publications/i/item/WHO-CED-PHE-EPE-19-4-3

62 iCliniq. (n.d.). Itai-Itai disease: Causes, symptoms, and prevention. https://www.icliniq.com/articles/diseases-and-disorders-common-medical-conditions/itai-itai-disease

63 UK Health Security Agency. (2016). Cadmium: Toxicological overview. https://www.gov.uk/government/publications/cadmium-properties-incident-management-and-toxicology/cadmium-toxicological-overview#:~:text=Cadmium%20has%20been%20classified%20as,reported%20(5%2C%207)

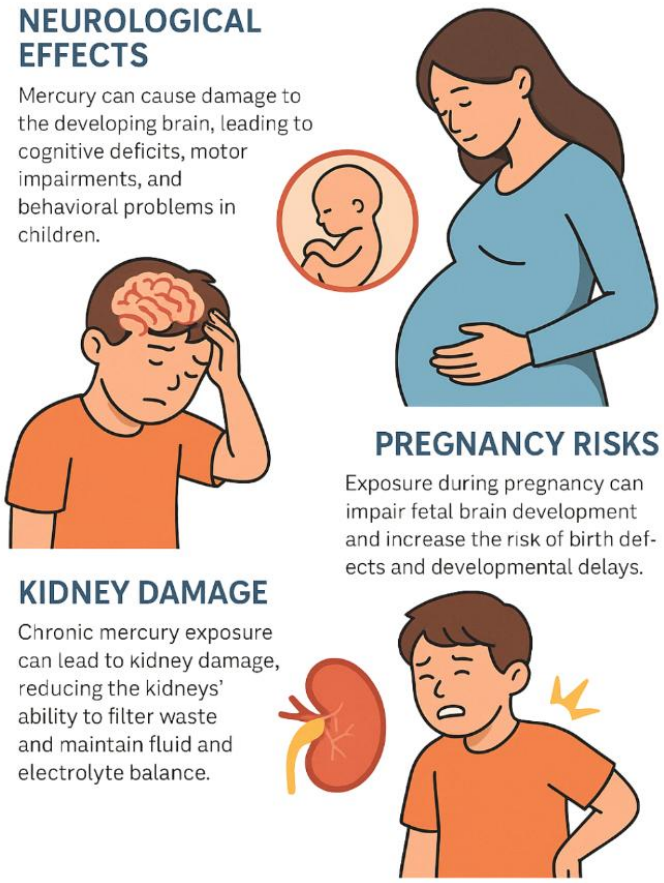
64 World Health Organization. (2017). Mercury and health. https://www.who.int/news-room/fact-sheets/detail/mercury-and-health

exposed to mercury show language delay, reduced IQ, visual-spatial defects, and poor coordination.

Minamata Disease: A tragic example from Japan where mercury-polluted fish caused neurodevelopmental disabilities and paralysis in hundreds of children[65].

Renal Effects

Inorganic mercury accumulates in the kidney cortex and disrupts cellular function through oxidative stress and apoptosis[66]. It can cause glomerulonephritis, acute tubular necrosis, and nephrotic syndrome in severe cases. Early symptoms include proteinuria, hematuria, and fatigue.



Carcinogenicity

Methylmercury compounds are listed as **Group 2B carcinogens**[67] (possibly carcinogenic to humans). It induces chromosomal instability and cell-cycle arrest. Though rare, kidney and skin cancers have been documented in chronically exposed populations.

7.4. Hexavalent Chromium (Cr VI)

Neurological Effects

Cr VI is less studied in children but is known to generate reactive oxygen species (ROS)[68] that can cause oxidative damage in the brain. Occupational exposure in adults has led to symptoms like headaches, memory impairment, and dizziness. Animal studies show **apoptosis in brain**

65 ScienceDirect. (n.d.). Minamata disease. In Nursing and Health Professions Topics. Elsevier. https://www.sciencedirect.com/topics/nursing-and-health-professions/minamata-disease
66Camacho, A., Montaño, M., Parrón, T., Requena, M., & Hernández, A. F. (2018). Exposure to inorganic mercury and human health in the Amazon: A systematic review. Toxics, 6(4), 66. https://europepmc.org/article/med/29867340
67 Salimi, A., Naderi, M., & Pourahmad, J. (2022). A mechanistic review of mercury-induced neurotoxicity and current therapeutic approaches. Toxicology and Applied Pharmacology, 447, 116095. https://www.sciencedirect.com/science/article/abs/pii/S0278691522001995.
68 Vahter, M. (2008). Health effects of early life exposure to arsenic. Basic & Clinical Pharmacology & Toxicology, 102(2), 204–211. https://pmc.ncbi.nlm.nih.gov/articles/PMC4027954/

cells, suggesting that long-term low-dose exposure may be more dangerous than previously thought.

Renal Effects

Cr VI is nephrotoxic and can cause: acute kidney injury through direct tubular necrosis and chronic interstitial nephritis after prolonged low-level exposure.

Carcinogenicity

Cr VI is a **Group 1 carcinogen**[69] with strong epidemiological evidence linking it to: lung cancer among chromate workers and nasal, sinus, and gastrointestinal cancers

7.5. Arsenic (As)

Neurological Effects

Arsenic disrupts neuronal signaling pathways, affects neurotransmitter levels, and interferes with neurodevelopment[70]. It is associated with lower IQ, language delay, and poor executive function in children. Epidemiological studies in Bangladesh[71] and Taiwan found that arsenic in drinking water correlated with increased risk of ADHD and developmental delays.

Renal Effects

Arsenic exposure causes renal vascular damage, leading to microalbuminuria and elevated creatinine levels. It may result in hypertensive nephropathy over time.

Carcinogenicity

Arsenic is a **Group 1 carcinogen**[72] linked to: Skin, bladder, kidney, lung, and liver cancers. It promotes cancer via **epigenetic disruption**, **chromosomal aberrations**, and **immune suppression**.

69 UK Health Security Agency. (2021). Chromium: Toxicological overview. GOV.UK. https://www.gov.uk/government/publications/chromium-general-information-incident-management-and-toxicology/chromium-toxicological-overview
70 World Health Organization. (2018, February 15). Arsenic. https://www.who.int/news-room/fact-sheets/detail/arsenic
71 Islam, M. S., Rahman, M. M., & Bakar, M. A. (2022). Arsenic toxicity: Molecular mechanisms and therapeutic strategies. Environmental Advances, 7, 100122. https://www.sciencedirect.com/science/article/pii/S2773049222000046
72 World Health Organization. (2018, February 15). Arsenic.

7.6. Why It Matters in Bangladesh

Children aged 0-5 years are especially vulnerable to toxic exposure from heavy metals due to their developing brains, immature organs, and frequent hand-to-mouth behavior. Even low levels of lead, cadmium, or mercury can cause lifelong neurological, renal, and developmental damage. Most toys sold in popular markets like Chawkbazar often bypass safety screening and contain recycled plastics and unregulated pigments, many of which are contaminated with hazardous heavy metals.

Unlike countries with strict toy safety laws (e.g., EN 71-3 in the EU or CPSIA in the USA), Bangladesh lacks national standards limiting heavy metals in toys. As a result, children are routinely exposed to toxic materials without any warning or protection. Studies by ESDO and others have confirmed that toys sold in Bangladesh can contain lead and cadmium levels up to 30 times higher than international safety limits, posing serious risks of cognitive decline, kidney damage, and even cancer in children.

Chapter Eight

Environmental Impacts of Heavy Metals from Toys

8. Environmental Impacts of Heavy Metals from Toys

In Bangladesh, the environmental impact of heavy metals from discarded plastic toys extends far beyond the landfill. These metals leach into soil, air, and water, travel through food chains, and ultimately impact the most vulnerable, **children**. Improper disposal, open burning, and informal recycling of toys create invisible but potent contamination routes, especially in low-income and urban areas like Dhaka, where regulatory enforcement is weak.

Below is an exploration of how each toxic metal enters the environment through toys and how these pathways endanger children's health.

8.1. Lead (Pb): A Persistent Soil and Air Threat

Lead-based pigments, especially **lead chromate**, are often used in bright-colored toys such as reds and yellows. When these toys are discarded in open spaces or burned in informal recycling zones, lead particles are released into the surrounding soil and air[73].

Soil contamination is particularly dangerous. Children playing outdoors, especially in open fields near urban slums or waste sites, are exposed through hand-to-mouth activity, inhaling dust, or ingesting contaminated soil. Once in the environment**,** lead binds tightly to topsoil, where it can remain for decades. Rain can wash these particles into nearby water bodies or gardens, contaminating food crops. Indoor exposure also occurs when contaminated soil is tracked into homes on shoes or clothes. A 2023 study in Dhaka found **soil lead levels over 700 mg/kg** within 50 meters of mixed toy disposal sites, **eight times higher** than the US EPA's residential safety threshold[74].

73 U.S. Environmental Protection Agency. (2023, August 31). Protect your family from sources of lead. https://www.epa.gov/lead/protect-your-family-sources-lead

74 Pure Earth. (2023, July 20). Bangladesh: New studies reveal alarming findings on lead pollution; need for urgent multi-sectoral actions.

8.2. Cadmium (Cd): A Silent Infiltrator of Food Chains

Cadmium, used in plastic stabilizers and pigments (often in red, yellow, and orange toys), is released into the environment via weathering, open burning, or disposal in landfills. Cadmium's environmental mobility makes it especially dangerous in Bangladesh's acidic and flood-prone soils. Once in the soil, cadmium is easily taken up by rice plants, a staple food for children, and can enter their bodies through daily meals. Cd also settles in pond sediments, where it bioaccumulates in aquatic species like carp and tilapia, fish frequently consumed by children and pregnant women. Long-term ingestion contributes to kidney damage and weak bone formation, increasing susceptibility to fractures in childhood[75].

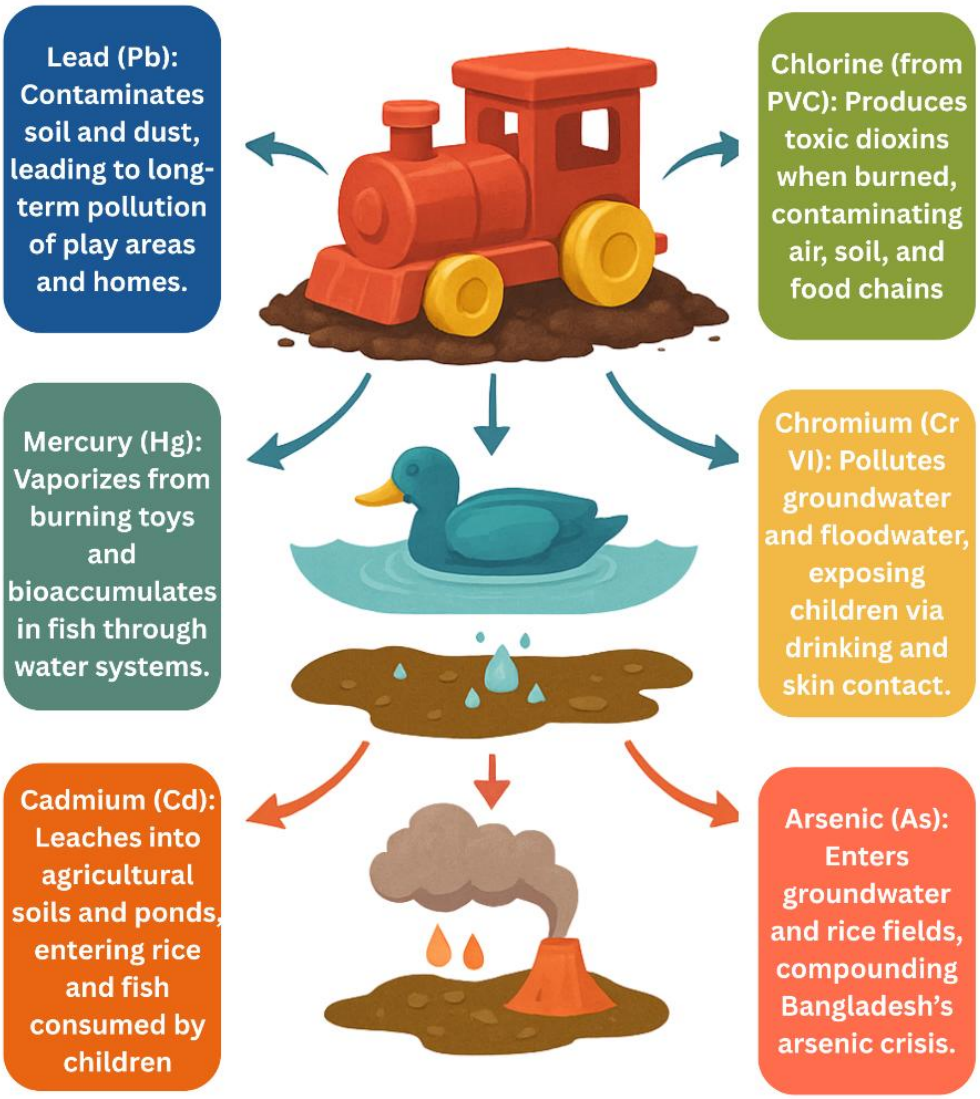
8.3. Mercury (Hg): From Smoke to Brain

Mercury can be present in small batteries inside toys or in pigment residues. Burning plastic toys or electronic components in open air releases mercury vapor, which is then deposited on surface waters like rivers and wetlands. In aquatic environments, microorganisms convert mercury into methylmercury (MeHg), a highly toxic form that accumulates up the food chain. Children and pregnant women consuming contaminated fish from rivers like the Turag or Buriganga may unknowingly ingest high levels of MeHg. Methylmercury crosses the placenta and the blood-brain barrier, damaging the developing brain and nervous system, resulting in delayed speech, poor coordination, and reduced cognitive function. UNEP classifies Dhaka's River fish as "**unsafe for frequent child consumption**", especially for pregnant women[76].

8.4. Chromium (Cr VI): A Hidden Danger in Water and Air

Chromium, particularly hexavalent chromium (Cr VI), is sometimes found in the yellow pigments used in plastics. When toys are crushed or burned during informal recycling, Cr VI can leach into the air or nearby groundwater. Cr VI is water-soluble and easily migrates through Bangladesh's sandy soils into tube-well aquifers often the primary source of drinking water in rural and peri-urban areas. Children exposed to Cr VI in drinking water face risks of skin irritation, allergic reactions, and even increased cancer risk with prolonged ingestion[77]. During monsoons, surface flooding can spread chromium across playgrounds and fields, increasing skin and dermal contact. The Institute of Water Modelling (2024) detected Cr VI concentrations of **52 µg/L** in tube-well water in Mirpur, 10 times the WHO guideline[78].

75 Biswas, A., Islam, M. S., & Khan, M. H. R. (2024). Lead exposure through informal battery recycling and its health implications in Bangladesh. Ecotoxicology and Environmental Safety, 268, 115684.
76 United Nations Environment Programme. (2023). Global Mercury Assessment 2023.
77 Agency for Toxic Substances and Disease Registry. (n.d.). About toxicological profiles. Centers for Disease Control and Prevention. https://www.atsdr.cdc.gov/toxicological-profiles/about/index.html
78 Das, S., Hossain, M. B., Kabir, S., & Akhand, M. A. I. (2024). High levels of lead and other heavy metals found in children's toys and household items in Bangladesh. Scientific Reports, 14(1), 77425. https://doi.org/10.1038/s41598-024-77425-3



8.5. Arsenic (As): The Groundwater Threat Reinforced by Waste

While arsenic is infamous in Bangladesh's groundwater, improper disposal of arsenic-containing dyes or recycled plastic worsens the problem. Incineration of such materials can lead to arsenic-laden ash, which settles on fields and gardens. This arsenic then leaches back into groundwater[79], especially in areas already prone to natural arsenic deposits. Surface irrigation using arsenic-rich water further contaminates rice, vegetables, and soil, closing the loop of exposure. Arsenic exposure in early childhood or pregnancy is linked to cognitive decline, weakened immunity, and even birth defects.

79 British Geological Survey. (n.d.). Arsenic contamination of groundwater.

Mapping by the British Geological Survey (2023) revealed arsenic contamination hotspots overlapping with informal toy and e-waste dumping sites[80].

8.6. Chlorine (Cl) - Dioxins in the Air

Chlorine is abundant in PVC (polyvinyl chloride) plastics, widely used in cheap toys. When these are burned in open-air dumps (a common practice), they release: Dioxins and furans, which are among the most toxic compounds known to humans. These chemicals persist in the environment, settle on crops, enter milk and meat, and bioaccumulate in the human body. Children are particularly vulnerable because Dioxins disrupt hormonal balance and immune function, and are linked to cognitive disorders and developmental delays. WHO recognizes dioxins as **persistent organic pollutants (POPs)** with known reproductive and developmental toxicity[81].

8.7. Bromine (Br) - Hidden Flame Retardants in Dust

Brominated flame retardants (BFRs), like **PBDEs**, are sometimes added to toys to meet flammability standards[82]. These are not chemically bound and leach into the environment via dust and degradation. In indoor settings, BFRs accumulate in household dust and settle on children's toys, floors, and surfaces. Children, especially infants crawling or mouthing objects, ingest brominated compounds, which act as **endocrine disruptors**. BFRs are linked to thyroid dysfunction, attention disorders, and early puberty.

Toxic toys do not just poison the hands that play with them—they pollute the environment that children grow up in. The improper handling, disposal, and recycling of plastic toys release heavy metals that contaminate air, soil, water, and food. These metals then re-enter children's bodies through multiple pathways- touch, inhalation, and ingestion.

The lack of safe waste management and weak regulation in Bangladesh magnifies the long-term environmental and health toll. To protect future generations, urgent action is needed to implement safe disposal practices, stricter import controls, and community-level monitoring near informal markets and dumps.

80 British Geological Survey. (n.d.). Arsenic contamination in Bangladesh: Maps of groundwater arsenic.
81 World Health Organization. (2016, October 4). Dioxins and their effects on human health.
82 Agency for Toxic Substances and Disease Registry. (n.d.). About toxicological profiles. Centers for Disease Control and Prevention.

Chapter Nine

Toxic Toys in Bangladesh

9. Discussion: Toxic Toys in Bangladesh

A Hidden Crisis of Policy, Plastic, and Public Health

Despite the playful appearances and bright colors, many plastic toys sold in Bangladesh are laced with a cocktail of toxic substances. The findings from this investigation reveal not only systemic violations of safety limits but a broader public health emergency, one quietly unfolding in homes, daycare centers, and markets across the country. This discussion unpacks the reasons why these hazardous toys persist, focusing on structural challenges, informal manufacturing practices, weak regulatory mechanisms, and global policy gaps 8.1. Informal Manufacturing and Hazardous Recycling Practices

The toy industry in Bangladesh, particularly in urban hubs like Dhaka's Chawkbazar, is dominated by small-scale and informal manufacturers who often rely on recycled plastics from industrial waste and electronic scrap. These recycled materials, including PVC, WEEE (waste electrical and electronic equipment), and old wiring casings, are frequently contaminated with heavy metals like lead, cadmium, and chromium, as well as additives such as brominated flame retardants (BFRs) and phthalates[83].

In this study, over **70% of the tested toys** exceeded international limits for at least one toxic metal, and several toys contained **multiple simultaneous violations**, including lead levels up to **2350 ppm** (26× above the EU and US limit of 90 ppm), chromium up to **4300 ppm**, and bromine up to **39,000 ppm**. These figures suggest not occasional lapses but routine use of contaminated or industrial-grade inputs. Similar findings have been reported in India, Indonesia, and the Philippines, where informal toy producers use e-waste and reject plastics to cut costs[84] [85].

83 IPEN. (2021). Plastics, Toxic Chemicals and Health. Retrieved from https://ipen.org
84 GAIA. (2020). Toxic Plastics in Asia's Informal Markets.
85 BAN Toxics. (2022). Heavy Metal Content in Philippine Children's Toys.

9.2. Regulatory Vacuum: The Absence of National Safety Standards

Bangladesh has no specific legal framework to regulate chemical safety in children's toys. While the Bangladesh Standards and Testing Institution (BSTI) issues voluntary safety standards, enforcement remains weak, and toy manufacturers are not legally required to test for toxic substances like lead, cadmium, or antimony.

In contrast, the European Union's Toy Safety Directive (EN 71-3) and the U.S. Consumer Product Safety Improvement Act (CPSIA) impose mandatory chemical testing, labeling requirements, and strict penalties for non-compliance[86].

Due to this regulatory gap, both locally produced and imported toys, including those from manufacturers like Ao Hai (China) and multiple Bangladeshi brands, continue to circulate freely in markets, schools, and homes without inspection. Customs and port authorities lack equipment like XRF analyzers or GC-MS systems, and there are no protocols for random toy screening or recall.

A study by ESDO in 2013 found that toys sold in major Bangladeshi markets exceeded allowable limits for lead by 30 times and cadmium by 10 times, consistent with the findings of this new investigation87. Yet, over a decade later, Bangladesh still has no binding legislation prohibiting chemically unsafe toys.

9.3. Consumer Unawareness: Bright Colors, Hidden Dangers

In the absence of chemical labeling or awareness campaigns, many caregivers assume that the more colorful or attractive a toy is, the safer or more educational it must be. However, vivid red, yellow, orange, and blue pigments often rely on chromium, cadmium, or lead compounds, substances banned in children's products in most developed countries88.

Parents and guardians in Bangladesh rarely have access to information about toy materials, toxicity, or the manufacturer's origin. Without proper labeling, chemical testing, or consumer alerts, they unknowingly purchase items that may impair their children's brain development, kidney function, or immune response for life. The World Health Organization (WHO) has clearly stated that "there is no safe level of lead exposure in children."[89], yet toxic toys remain normalized and even celebrated as gifts for birthdays, religious festivals, and school events.

86 U.S. Consumer Product Safety Commission. (2008). Consumer Product Safety Improvement Act.
87 Environment and Social Development Organization (ESDO). (2013). Toxic Toys in Bangladesh: An Overview.
88 Chen, A., Dietrich, K. N., Ware, J. H., et al. (2021). "IQ and Blood Lead Levels in Children." Environmental Health Perspectives, 129(4).
89 World Health Organization. (2010). Childhood Lead Poisoning. Retrieved from https://www.who.int

9.4. Global Lessons: What Bangladesh Can Learn from Other Countries

In 2007, the U.S. recalled more than 1.5 million Mattel toys made in China for excessive lead content90. This crisis led to the passage of CPSIA (2008), mandating third-party testing for every toy sold in the U.S. Since then, toy recalls have plummeted, and companies must prove compliance before entering the market.

Similarly, the European Union's EN 71-3 directive limits the migration of 19 heavy metals in toys, requiring regular testing and disclosure. Even neighboring India amended its Quality Control Order in 2020 to restrict lead, cadmium, and phthalates in imported and domestically produced toys91.

Bangladesh, by contrast, has yet to develop a legally binding standard for chemical safety in children's products, or to join regional initiatives such as SAARC harmonization of toy safety protocols. This inaction has turned the country into a toxic dumping ground for both poorly made local toys and low-cost imports rejected by more regulated markets.

9.5. Cumulative Health Risks and Children's Rights Violations

What makes this crisis more urgent is the cumulative and irreversible nature of the damage. Children, especially between ages 0–5, are not only more exposed (due to hand-to-mouth behavior and frequent mouthing of toys) but also more biologically vulnerable. Toxins like lead and mercury can cross the blood-brain barrier and placenta, impairing neurodevelopment long before symptoms appear92.

- Long-term effects documented in international and local research include:
- IQ loss and attention disorders
- Speech and language delays
- Kidney dysfunction and immune suppression
- Increased risk of cancer (e.g., bladder, lung, skin)

These are not just health risks; they are violations of children's fundamental rights to a safe, non-toxic environment, as enshrined in the UN Convention on the Rights of the Child (CRC), which Bangladesh ratified in 1990.

90 U.S. CPSC. (2007). Recall of Mattel Toys. Retrieved from https://www.cpsc.gov
91 Bureau of Indian Standards (BIS). (2020). Toys (Quality Control) Order.
92 Centers for Disease Control and Prevention (CDC). (2022). Lead Exposure and Children. Retrieved from https://www.cdc.gov

Chapter Ten

Recommendation

10. Recommendations

10.1. Establish National Toy Safety Standards

Develop and enforce heavy metal limits (e.g., for Pb, Cd, Hg, Cr VI, As) in line with international regulations such as EU EN 71-3, US CPSIA, and ISO 8124-3.

Include chlorinated and brominated compounds (e.g., PVC, PBDEs) in the list of restricted substances in toys.

Make testing mandatory for both **imported and locally produced toys**, with third-party certification before market entry.

10.2. Mandatory Labeling and Traceability

Require toy manufacturers and importers to label products with origin, materials, and compliance marks.

Introduce a QR code-based product tracking system for easy verification of safety standards by parents and retailers.

10.3. Strengthen XRF Screening Capacity

Equip BSTI (Bangladesh Standards and Testing Institution) and customs authorities with portable XRF analyzers for on-site screening.

Conduct random quarterly surveillance of local markets like Chawkbazar, New Market, and regional toy bazaars to test toys for toxic elements.

10.4. Create a National Toxic Toy Database

Develop a **public registry of tested and flagged toys**, regularly updated with product images, sources, and metal levels to inform consumers.

Publish **risk alerts** for toys exceeding permissible thresholds.

10.5. Ban Open Burning and Dumping of Toy Waste

Prohibit open burning of plastic toys and introduce fines for informal recyclers and markets that engage in this.

Set up designated collection points for end-of-life toys to enable safe recycling and disposal.

10.6. Control the Use of Recycled Plastics in Toy Manufacturing

Toy manufacturers should be prohibited from using recycled plastic feedstock that does not meet child safety standards, and should require pre-production testing of recycled materials intended for toy use.

A “Safe Recycled Plastic” certification scheme should be introduced, requiring recycled plastic suppliers to verify and disclose the chemical composition of their materials, modeled after the EU’s Circular Plastics Alliance or OECD’s Safe Plastics Framework.

Toy manufacturers should be required to maintain full documentation of their raw material sources, including batch-level tracking of recycled content.

10.7. Introduce EPR (Extended Producer Responsibility) for Toy Companies

Make producers/importers accountable for toy disposal through take-back programs.

Incentivize the use of non-toxic, biodegradable, or recyclable materials in toy manufacturing.

10.8. Nationwide Campaign on Toy Safety

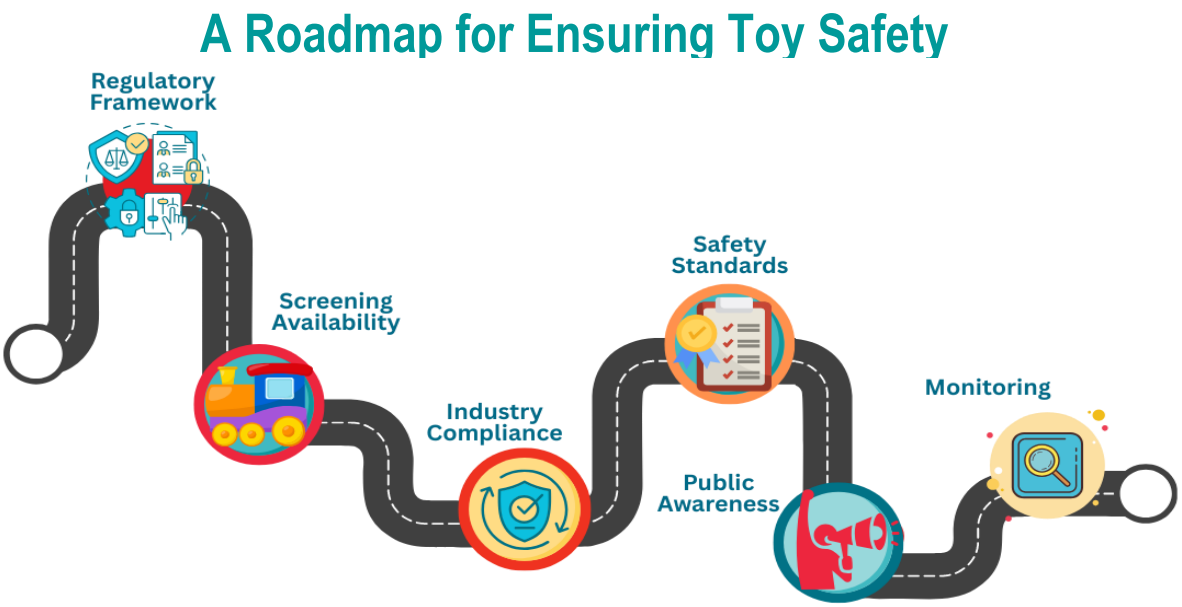
Launch a **multi-**lingual campaign (Bangla + regional dialects) using TV, social media, schools, and health clinics to educate parents on: Recognizing unsafe toys (e.g., strong smell, chipped paint, unlabeled products), choosing safer alternatives (wooden, certified toys), and Proper toy disposal and hygiene practices

10.8. Engage Pediatricians and School Teachers

Train **health professionals and school staff** to educate parents and children on symptoms of metal poisoning and the importance of toy safety.

10.9. Establish a National Children’s Health Registry

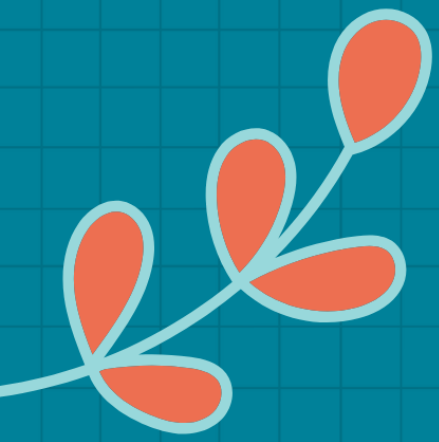
Track neurological, renal, and developmental conditions related to environmental exposures, supporting **early diagnosis and targeted interventions**.



10.10. Harmonize with International Trade Regulations

Ensure toys exported from or imported into Bangladesh **comply with RoHS, REACH, and WEEE** directives for toxic substances.

Children should not pay the price for play. These recommendations spanning policy, testing, waste management, education, and global cooperation offer a comprehensive path toward eliminating toxic toys from Bangladeshi markets and protecting the next generation.



Chapter Eleven
Conclusion

11. Conclusion

This study presents a sobering account of the toxic hazards concealed within everyday plastic toys that are widely available and commonly used by children across Bangladesh. The analysis of **70 plastic toy samples**, sourced from local markets including the prominent Chawkbazar wholesale hub, has revealed the presence of several heavy metals, namely **lead, cadmium, mercury, chromium, and arsenic** as well as halogenated elements like **chlorine and bromine**. Many of these were detected at concentrations that significantly exceed internationally recognized safety thresholds. These findings indicate not isolated contamination, but a systemic issue within toy manufacturing, importation, and informal recycling in the country.

Children between the ages of 0 and 5, who are developmentally and biologically most vulnerable, are disproportionately affected by such exposures. Their frequent hand-to-mouth behavior, higher metabolic absorption rates, and immature organ systems make them especially susceptible to the neurological, renal, immunological, and developmental impacts of these toxic substances. Furthermore, the risk extends even before birth pregnant women exposed to mercury, arsenic, or brominated compounds through environmental routes may unknowingly compromise fetal development, increasing the risk of low birth weight, birth defects, or lifelong cognitive impairments in their children.

The health risks, however, represent only part of the story. Equally disturbing is the environmental trajectory of these toxins. Discarded or damaged plastic toys are often dumped in landfills, buried in backyards, or burned in the open air as part of informal waste disposal or recycling. These actions release toxicants into the surrounding soil, water, and air. Heavy metals leach into soil and accumulate in food crops such as rice and vegetables. Mercury released from combustion deposits into water bodies where it converts into methylmercury, a highly toxic form that bioaccumulates in fish consumed by the population. Chromium and arsenic migrate into groundwater and irrigation systems, contaminating the nation’s primary drinking and agricultural sources. Chlorinated and brominated compounds, especially from PVC and flame retardants in toys, generate persistent organic pollutants like dioxins and furans when burned, which not only pollute the environment but also enter food systems and human bodies via inhalation and ingestion.

The lack of national regulation on heavy metal content in toys in Bangladesh creates a wide gap in consumer protection. There is currently no comprehensive, enforceable law or mandatory testing system that ensures toys on the market are free from harmful substances. Import controls are insufficient, allowing hazardous toys, both new and secondhand to flood local markets. Informal toy recycling practices, particularly in low-income urban areas, further exacerbate the issue by reselling toxic products without safety verification or awareness. Public knowledge about these dangers is minimal, and there is virtually no government-led awareness campaign or health monitoring system in place.

This situation underscores the urgent need for a coordinated national response. The government of Bangladesh must prioritize the development and enforcement of legally binding toy safety standards, aligned with international benchmarks such as the EU EN 71-3 and the US CPSIA.

Regulatory agencies should be equipped with advanced tools like portable XRF analyzers to facilitate efficient testing of toys in markets and at points of import. Waste management protocols must include bans on the open burning of toy plastics, establishment of safe disposal units, and formalization of toy recycling systems that ensure toxic materials are safely managed. The engagement of pediatricians, educators, and community leaders is also vital to raise awareness about early symptoms of toxic exposure and best practices for toy use and hygiene. Meanwhile, manufacturers and importers must be held accountable under an Extended Producer Responsibility (EPR) framework that includes take-back programs and labeling transparency.

Most importantly, the right to a safe and healthy childhood must be treated as a national priority. Children must not suffer the consequences of lax enforcement, corporate negligence, or policy inaction. The evidence presented in this study makes it clear that the threat posed by toxic toys is real, widespread, and escalating. Addressing it will require collaboration across public health, environmental protection, consumer safety, and industry regulation sectors. By taking swift, evidence-based action, Bangladesh has the opportunity to protect not only its youngest citizens but also its ecosystems, food systems, and future generations.

This is more than a matter of toy safety; it is a test of our collective responsibility to safeguard human health and the environment from preventable harm. The solutions exist. The science is clear. Now is the time to act.

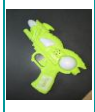
Annex

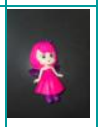
Pictorials


RoHS Plus
El PPM +/- 3σ
Cd ND <80
Sb 760 220
Hg 1080 720
Cr 1400 1300
Pb 1630 740
Br 2.34% 0.47

Tables

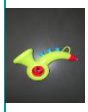
Table: List of Toys and Heavy Metals Detected

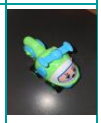
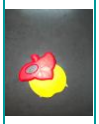
Label No	Categories/ Type of Toy	Vendor/ Manufacturer	Country of Origin	As	Cl	Pb	Cd	Sb	Cr	Ba	Br	Hg	Images
TS001	Car (Orange)	Aman Toy Garden	Bangladesh	163	0	630	47	3190	890	0	8800	170	
TS002	Car (Red)	Aman Toy Garden	Bangladesh	0	0	590	81	2700	0	0	7090	0	
TS003	Car (Blue)	Aman Toy Garden	Bangladesh	101	0	2350	98	1350	1400	0	23400	1080	
TS004	Fan (Yellow)	Aman Toy Garden	Bangladesh	0	0	162	0	353	0	0	640	0	
TS005	Car (Blue)	Zihan Plastic Industry	Bangladesh	88	0	106	56	0	690	0	122	0	
TS006	Car (Yellow)	Zihan Plastic Industry	Bangladesh	45	0	257	31	105	0	359	33	71	
TS007	Car (Orange)	Zihan Plastic Industry	Bangladesh	83	0	650	0	101	840	32	25	0	
TS008	Jazz Beat Drum	Zihan Plastic Industry	Bangladesh	42	0	0	46	0	850	0	9	0	
TS009	Gun (Green)	Red Apple Toys	Bangladesh	0	0	99	0	175	0	0	366	0	
TS010	Gun (Yellow)	Red Apple Toys	Bangladesh	0	0	23	0	170	0	563	0	0	

TS011	Gun (Orange)	Red Apple Toys	Bangladesh	0	0	0	251	0	2110	0	251	0 
TS012	Baby Concert Funny little toy (Orange)	F.R. Toys	Bangladesh	24	0	0	0	173	780	0	57	56 
TS013	Baby Concert Funny little toy (Green)	F.R. Toys	Bangladesh	14	0	0	0	111	2800	0	0	230 
TS014	Puzzles (Air bus)	Kader Plastic Products	Bangladesh	0	100000	128	0	137	1260	0	48	0 
TS015	Speed Water Gun	Shahjahan Plastic Industries	Bangladesh	19	0	0	0	310	510	0	5	0 
TS016	Barbie Doll Blue	Nazrul Toy Industry	Bangladesh	0	0	39	0	253	620	0	0	0 
TS017	Barbie Doll Pink	Nazrul Toy Industry	Bangladesh	60	100000	0	0	102	1280	14	14	0 
TS018	Barbie Doll Purple	Nazrul Toy Industry	Bangladesh	58	100000	670	0	240	0	0	240	0 
TS019	Yamaha Honda Police Car Set Orange	Karim Toys	Bangladesh	0	100000	2400	0	0	0	0	322	0 

TS020	Yamaha Honda Police Car Set Pink	Karim Toys	Bangladesh	42	100000	880	0	114	0	182	182	0	
TS021	Yamaha Honda Police Car Set Yellow	Karim Toys	Bangladesh	15	0	84	61	0	1040	0	0	57	
TS022	Yamaha Honda Police Car Set white	Karim Toys	Bangladesh	92	0	48	0	94	1900	65	65	0	
TS023	Sniper Back Car Orange	Khokon Plastick Products	Bangladesh	0	100000	142	106	243	0	0	497	57	
TS024	Sniper Back Car Red	Khokon Plastick Products	Bangladesh	44	0	135	52	413	2600	0	499	0	
TS025	Sniper Back Car Blue	Khokon Plastick Products	Bangladesh	42	0	97	101	362	750	0	720	67	
TS026	Sniper Back Car Green	Khokon Plastick Products	Bangladesh	157	0	95	0	290	0	0	850	53	
TS027	Burger Set Pizza Pink	Shahjalal Toys Gallery	Bangladesh	0	0	0	640	710	760	0	380	0	
TS028	Burger Set Coca Cola Orange	Shahjalal Toys Gallery	Bangladesh	0	0	0	98	0	1800	0	3	0	

TS029	Burger Set French Fry	Shahjalal Toys Gallery	Bangladesh	0	100000	0	260	164	1220	0	64	0	
TS030	Burger Set Burger	Shahjalal Toys Gallery	Bangladesh	52	100000	75	79	147	0	0	140	0	
TS031	Pori Barbie Khat Almirah	Pyramid Toy and Company	Bangladesh	66	100000	220	0	0	1810	0	20	0	
TS032	Pori Barbie Khat Dressing Table	Pyramid Toy and Company	Bangladesh	0	100000	90	470	0	1010	0	20	330	
TS033	Angel Doll	Amir Toys	Bangladesh	36	0	0	79	161	1290	0	22	0	
TS034	Angel Doll Bag	Amir Toys	Bangladesh	30	100000	0	46	90	0	0	3	0	
TS035	Angel Doll Hair dryer	Amir Toys	Bangladesh	28	100000	0	69	161	0	0	49	0	
TS036	Meena Mickey jhuna Set Blue	M M Toys	Bangladesh	46	100000	0	380	94	890	0	52	86	
TS037	Meena Mickey jhuna Set Pink	M M Toys	Bangladesh	9	0	0	0	196	1500	0	36	0	
TS038	Meena Mickey Jhuna Set	M M Toys	Bangladesh	0	100000	0	0	97	870	0	9	33	

TS039	Cartoon Animal Juna Dolphin Pink	J B Toys (Pyramid)	Bangladesh	46	100000	46	172	0	0	0	124	0	
TS040	Cartoon Animal Juna Guitar	J B Toys	Bangladesh	28	100000	0	80	111	1500	0	51	67	
TS041	Cartoon Animal Juna Rabbit	J B Toys	Bangladesh	0	100000	400	0	111	1200	0	0	0	
TS042	Cartoon Animal Juna Trumphet	J B Toys	Bangladesh	0	0	103	79	123	1680	0	0	140	
TS043	Cartoon Animal Juna Cat	J B Toys	Bangladesh	67	100000	0	61	0	1950	0	23	220	
TS044	Happy fight cut Basket Pink	Tajul Plastic toys Industry	Bangladesh	4	0	60	0	194	1800	0	21	0	
TS045	Happy fight cut Carrot	Tajul Plastic toys Industry	Bangladesh	4	0	0	0	194	1900	22	0	0	
TS046	Happy fight cut Brinjal	Tajul Plastic toys Industry	Bangladesh	0	0	97	62	156	1120	0	0	0	
TS047	Happy fight cut	Tajul Plastic toys Industry	Bangladesh	0	100000	0	0	116	1800	0	34	0	

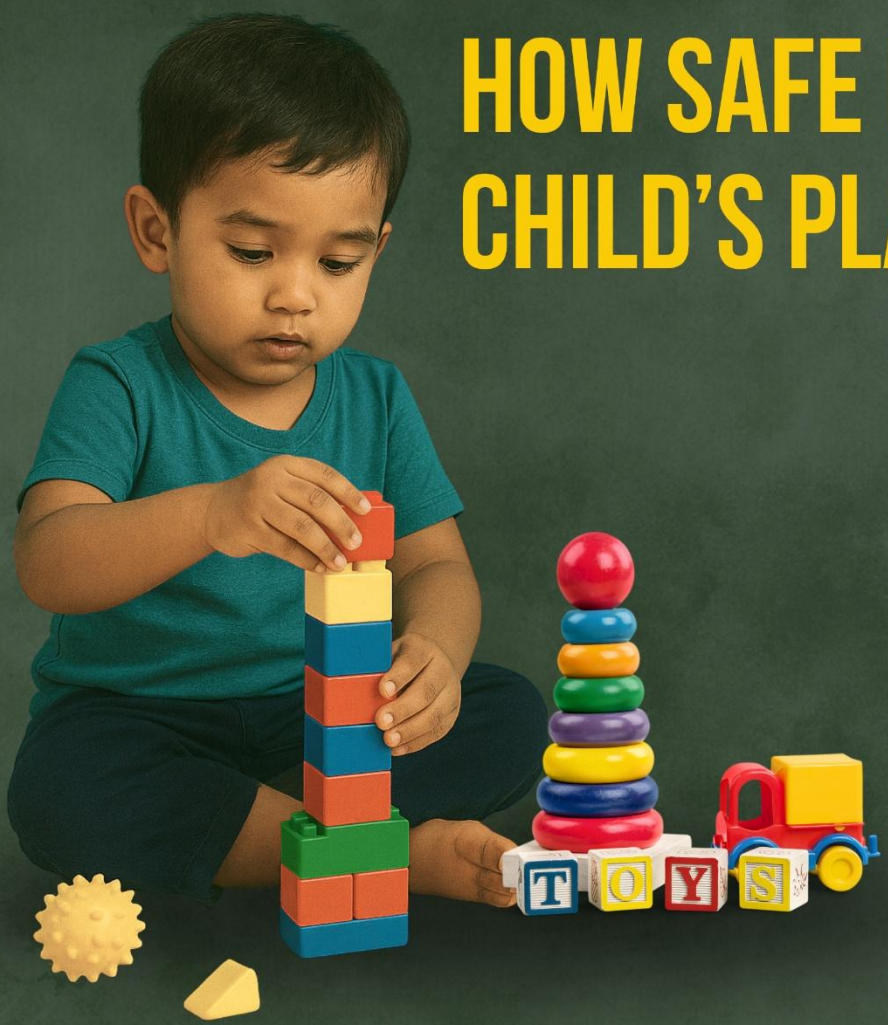
TS048	Happy fight cut Fish	Tajul Plastic toys Industry	Bangladesh	34	100000	0	62	83	0	0	0	0	
TS049	Car set Green Helicopter	Ao Hai	China	19	0	160	157	0	790	0	206	0	
TS050	Blue Police Car	Ao Hai	China	0	100000	92	0	166	600	0	495	0	
TS051	Red Fire truck	Ao Hai	China	0	0	76	0	185	4300	0	228	490	
TS052	Pink Ambulance	Ao Hai	China	0	0	0	0	112	680	0	230	92	
TS053	Baby Concert Funny Little Toy Yellow	Huabiao Toys	China	0	100000	0	41	77	1750	0	4	94	
TS054	Baby Concert Funny Little Toy Blue	Huabiao Toys	China	0	0	0	0	0	1060	0	25	0	
TS055	Baby Concert Funny Little Toy Orange	Huabiao Toys	China	13	100000	0	29	0	590	0	24	0	
TS056	Baby Concert Funny Little Toy Red Drum	Huabiao Toys	China	13	100000	0	0	0	750	0	71	0	

TS057	Chicken, orange and yellow	Unnamed	Bangladesh	0	0	0	84	76	0	0	110	0	
TS058	Mickey Mouse Jhuna Blue-green	Unnamed	Bangladesh	0	100000	160	0	84	890	0	276	130	
TS059	Mickey Mouse Jhuna Orange	Unnamed	Bangladesh	14	100000	87	89	0	0	1810	386	160	
TS060	Mickey Mouse Jhuna Pink	Unnamed	Bangladesh	12	100000	320	500	159	2300	0	3900	0	
TS061	Mickey Mouse Jhuna Orange Glasses	Unnamed	Bangladesh	5	100000	30	33	0	0	0	4	0	
TS062	Number Block-Blue	PlayTimeToy_RFL Plastic Ltd.	Bangladesh	0	0	21	0	0	440	0	71	0	
TS063	Number Block-Yellow	PlayTimeToy_RFL Plastic Ltd.	Bangladesh	7	0	99	0	0	0	0	0	0	
TS064	Number Block-Orange	PlayTimeToy_RFL Plastic Ltd.	Bangladesh	0	0	15	0	0	0	0	14	0	
TS065	Number Block-Red	PlayTimeToy_RFL Plastic Ltd.	Bangladesh	15	0	0	0	50	520	0	118	43	
TS066	Number Block-Green	PlayTimeToy_RFL Plastic Ltd.	Bangladesh	0	0	0	0	0	520	0	118	0	
TS067	Friction mini car	RFL-Best Buy	China	7	0	0	216	0	410	0	26	0	

TS068	Friction bike toy-Orange	RFL-Best Buy	China	0	0	480	0	0	0	0	0	0	
TS069	Friction bike toy-Red	RFL-Best Buy	China	0	100000	480	0	260	0	0	0	0	
TS070	Friction Toy-Blue ship		China	0	0	88	0	150	2200	0	133	127	

COLORFUL OUTSIDE.
TOXIC INSIDE.

HOW SAFE IS OUR CHILD'S PLAYTIME?



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