ARE YOUR CHILDREN'S TOYS HAZARDOUS WASTE?

HIGH LEVELS OF CHLORINATED PARAFFINS IN PLASTIC TOYS FROM TEN COUNTRIES

October 2023

IPEN
for a toxics-free future

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HIGH LEVELS OF CHLORINATED PARAFFINS IN PLASTIC TOYS FROM TEN COUNTRIES

October 2023

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Sample preparation and screening Arnika - Toxics and Waste Programme

IPEN is a network of non-governmental organizations working in more than 120 countries to reduce and eliminate the harm to human health and the environment from toxic chemicals.

www.ipen.org

Arnika is a Czech non-governmental organization established in 2001. Its mission is to protect nature and a healthy environment for future generations both at home and abroad.

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Alaska Community Action on Toxics (ACAT) is a U.S.-based environmental health and justice organization that empowers communities to eliminate exposure to toxic chemicals through collaborative research, shared science, education, organizing, and advocacy. ACAT's mission: everyone has the right to clean air, clean water, and toxic-free food.

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ABSTRACT

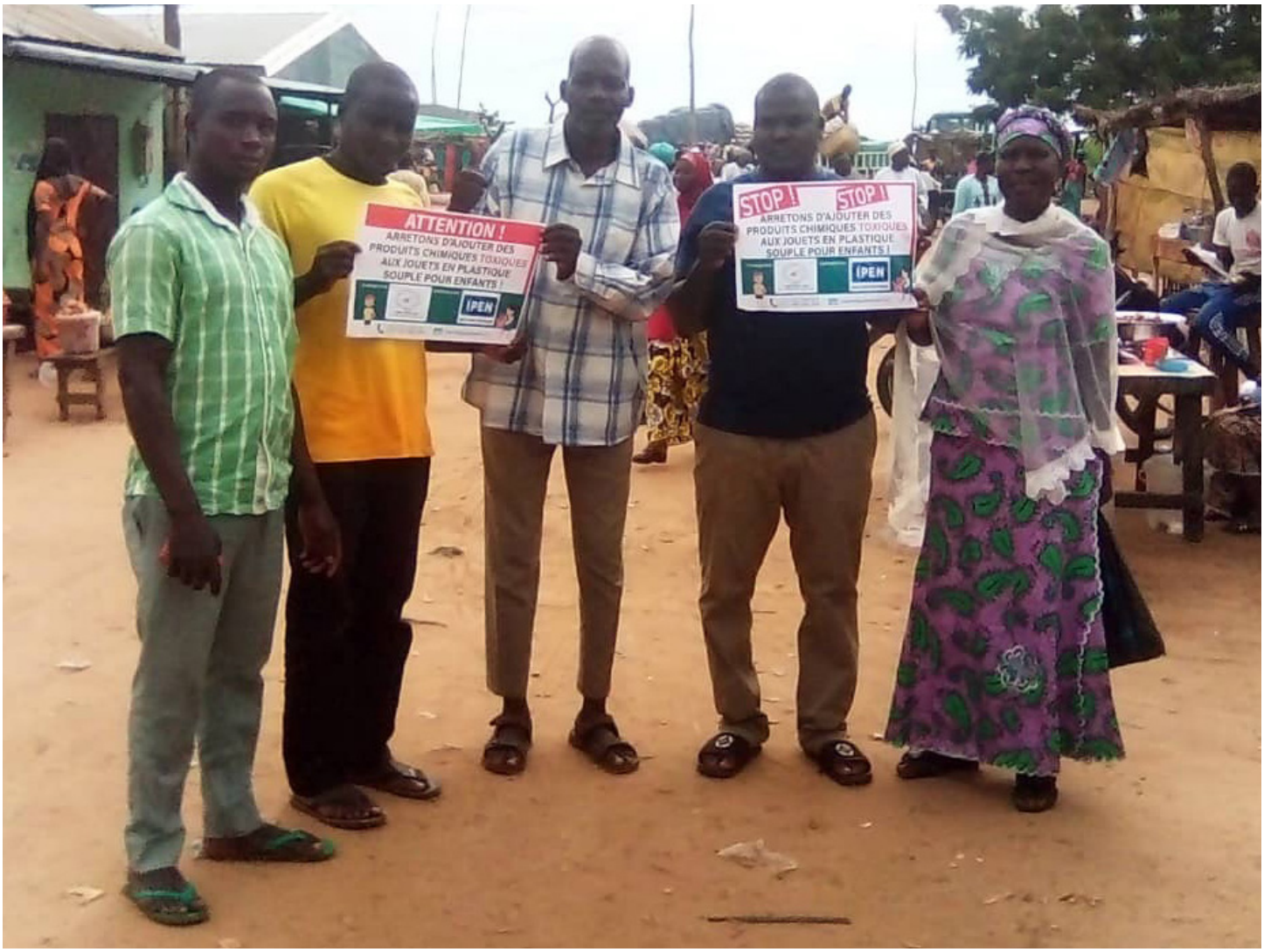
Chlorinated paraffins are some of the most hazardous and high production volume chemicals in the world. They are persistent, bioaccumulative, toxic and are released into the environment throughout their life cycle. They are carcinogenic, disrupt the endocrine system, and are neurodevelopmental and reproductive toxicants.

Chlorinated paraffins are divided into subgroups based on chain length, however all chain lengths exhibit harmful properties. SCCPs were banned under the Stockholm Convention on Persistent Organic Pollutants in 2017 and MCCPs are currently under evaluation for a potential global ban and warrant the same action. Chlorinated paraffins are used in plastic materials as flame retardants, adhesives, sealants, and secondary plasticizers throughout the world.

In this study, we analyzed 31 toys purchased in ten countries. Our results found both SCCPs and MCCPs in all of the toys, many at concentrations that exceed proposed limit values for hazardous wastes. In other words, plastic toys that children are playing with are so toxic that they could be classified as hazardous wastes.

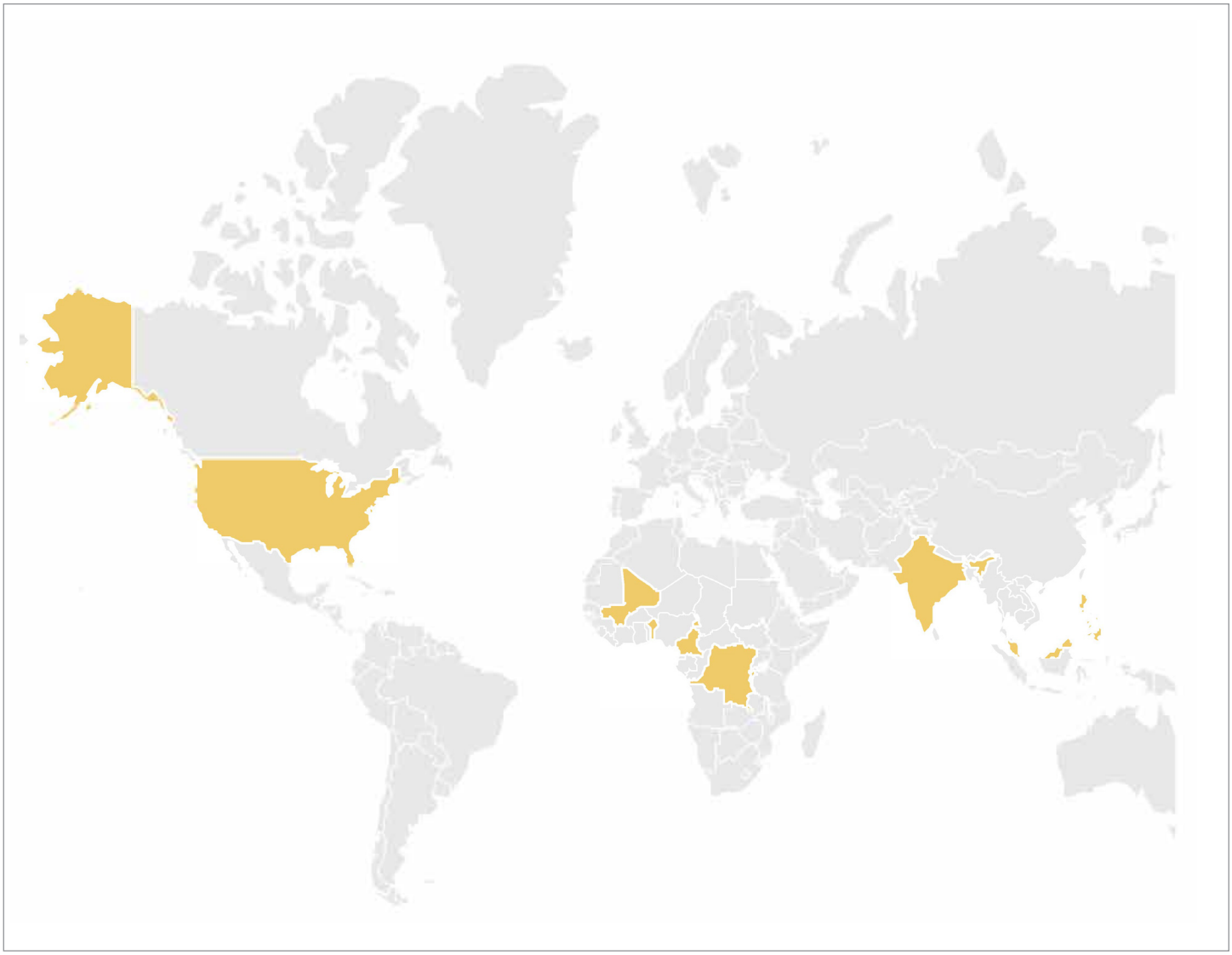
These results show how current gaps in the regulation of toxic chemicals are exposing children to some of the most hazardous chemicals in the world. The results also:

1. highlight the importance of regulating classes of chemicals to prevent replacing one toxic chemical with another (so-called "regrettable" substitutions);
2. demonstrate the harm of allowing exemptions for continued use of toxic chemicals; and
3. show the importance of transparency and traceability of chemicals used in plastics.



KEY FINDINGS

- Chlorinated paraffins are highly toxic chemicals used in many plastics, including in plastic children's toys. Evidence shows they may cause damage to the liver and kidneys, disrupt the endocrine system, cause cancer, damage developing brains, and pose threats to reproductive health.
- Testing showed that all 31 toys purchased from ten countries contained both short- and medium-chain chlorinated paraffins (SCCPs and MCCPs).
- Several toys contained levels of SCCPs that are so high they could be classified as hazardous waste.
- SCCPs have been globally banned and MCCPs are being evaluated for a global ban, yet testing shows these highly toxic chemicals remain in children's toys worldwide.
- Evidence shows chlorinated paraffins are released from plastics through their life cycle. Children can be exposed through skin contact, inhalation, dust, and ingestion.
- Studies show that current levels of exposure to chlorinated paraffins may be associated with adverse effects on human health.
- Sampling has found chlorinated paraffins in the environment all over the world, including in remote locations such as the Arctic.
- Evidence shows that since SCCPs have been banned they are being replaced with MCCPs, even though MCCPs are likely to be just as toxic. Rather than regulating chemicals one by one over decades, the results show the importance of restricting chemicals by classes, to avoid substituting one toxic threat with another.
- When SCCPs were banned, exemptions allowed some continued uses, despite the health and environmental risks. The results are a cautionary tale showing that allowing exemptions can result in ongoing toxic threats.
- None of the toys were labeled for the presence of toxic chemicals. The results show the importance of labeling and traceability throughout the plastics life cycle.



SAMPLES COLLECTED BY:

Jeunes Volontaires Pour L'Environment (JVE Benin) – Benin
Action pour l'Ecologie le Developpement et l'Amangement Durable (ACECODAD) - Burundi
Cameroonian Association for the Promotion of Sustainable Development (CAPSUDGO) - Cameroon
African Green Society (AFRIGRES) - Democratic Republic of Congo
Gramin Vikas Evam Paryavaran Samiti (GVEPS) - India
Consumers' Association of Penang (CAP Malaysia) – Malaysia
Appui pour la Valorisation et la Promotion des Initiatives Privées (AVPIP) - Mali
Ban Toxics – Philippines
Pro-biodiversity Conservationists In Uganda (Probicou) - Uganda
Alaska Community Action on Toxics (ACAT) - USA

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FOREWORD

The issue of chlorinated paraffins holds more than a scientific interest for me. I grew up in the small town of Dover, Ohio in the U.S., the site of a primary manufacturing facility for these chemicals. Dover Chemical Corporation continues to manufacture medium-chain chlorinated paraffins and the site is now designated as one of the most polluted sites in the nation, a Superfund site. The corporation has a decades-long record of chemical spills, releases to air, and improper disposal of hazardous wastes that have severely contaminated air, soils, ground water and surface waters—all of this within the community of Dover and watershed of Sugar Creek where we lived, attended school, drew our drinking water, played, picked strawberries, and fished. Our neighborhood and my family have suffered unusual rates of cancers and other health disparities.

Although the Dover Chemical Corporation poisons my home community, this is certainly not just a local issue. This dangerous class of chemicals harms workers and communities throughout the world. Chlorinated paraffins are manufactured in China, India, Japan, Republic of Korea, European Union, United Kingdom, USA, and Qatar. They are extremely persistent, toxic, and subject to long range transport from where they are manufactured, used, and disposed to remote locations throughout the planet. Chlorinated paraffins have been found worldwide in environmental samples, biota, and humans. A recent study reported that chlorinated paraffins were detected in all breast milk samples collected from women in 53 individual countries on five continents. Chlorinated paraffins threaten the health of traditional foods and peoples of the Arctic where I now live and work.

It is a travesty that chlorinated paraffins are found in children's toys as revealed in this study, and many of them above levels proposed for hazardous wastes. This is a terrible injustice and a violation of human rights. This study found that all of the children's toys analyzed from ten different countries contained short-chain chlorinated paraffins (SCCPs) and medium-chain chlorinated paraffins (MCCPs). Levels of the chemicals were very high, with toys containing as much as 6% by weight of SCCPs and 7% of MCCPs. None of these toys provided a label warning of the presence of highly toxic chlorinated paraffins.

These results demonstrate the failure of the chemical industry and regulatory agencies to provide adequate protection for children by not preventing their exposures to toxic plastic additives. As parents or grandparents, we should not have to worry about whether a toy we give to our child might expose her to chemicals that endanger her health. Concerted and urgent actions must be undertaken to ensure transparency throughout the supply chain, eliminate harmful chemicals, and ensure the safety of products for everyone and especially those most vulnerable.

Please read this report, heed its recommendations, and take action to hold corporations and governments accountable. We call upon decisionmakers to end the production and use of toxic chemicals in plastics, including the entire class of chlorinated paraffins.

Pamela Miller, IPEN Co-Chair and Executive Director, Alaska Community Action on Toxics

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BACKGROUND

WHAT ARE CHLORINATED PARAFFINS?

Chlorinated paraffins are a large group of high production volume industrial chemicals. Approximately one million tonnes and perhaps as much as two million tonnes are produced every year (Guida et al. 2020, Yuan et al. 2022). They are used in a wide range of products with different functions such as flame retardants, adhesives, sealants, and secondary plasticizers. They are especially common in polyvinyl chloride plastics (54% of the global volume usage) but are also used in many other types of plastics, rubber, and paints (UNEP/POPS/POPRC.19/2, UNEP/POPS/POPRC.12/11/Add.3). They are also widely used in metal working fluids. Typically, they are divided according to their carbon chain lengths:

Short-chained chlorinated paraffins (SCCPs): C10-C13
Medium-chained chlorinated paraffins (MCCPS): C14-C17
Long-range chlorinated paraffins (LCCPs): C18-C20

Aside from the classifications mentioned above, there are also shorter and longer chlorinated paraffins that fall outside of these classifications.

HISTORY

The production of chlorinated paraffins (CPs) started in the 1930s. By the 1980s, they were identified as potentially hazardous but nonetheless production continued to increase and by 2013 exceeded one million tonnes per year, making this group of chemicals one of the highest production volume chemicals in the world (Guida et al. 2020). Guida et al. (2020) reviewed the history of manufacturing of CPs that began in the 1930s and note that currently MCCPs and LCCPs represent the largest components of CP production.

In 2017, SCCPs were globally banned through a listing under the Stockholm Convention on Persistent Organic Pollutants (POPs). The Stockholm Convention is the only global legally binding mechanism to eliminate the world's most dangerous chemicals. The chemicals that are listed under the Convention are proven to be so toxic, persistent, and bioaccumulative that they are of global concern. They are also subject to long-range environmental transport that distributes them throughout the world, even into remote regions such as the Arctic and Antarctic.

Although SCCPs fulfilled all the criteria for listing and countries agreed to list them, the decision included several exemptions for continued production and usage, including as a plasticizer in polyvinyl chloride (PVC) plastics. These exemptions did not include toys because of concern about children's exposures.

Unfortunately, since SCCPs have been banned, there is evidence that MCCPs are increasingly used as substitutes for SCCPs. For example, monitoring has shown that MCCPs have started to dominate in several types of environmental samples (Glüge et al. 2018). But since the properties of chlorinated paraffins are very similar, irrespective of chain lengths, MCCPs are currently being evaluated under the Stockholm Convention. The POPs Review Committee (POPRC), a subsidiary body of the Stockholm Convention, found that MCCPs are "likely to lead to significant adverse human health and environmental effects such that global action is warranted." (UNEP/POPS/POPRC.12/11/Add.3).

CHLORINATED PARAFFINS ARE TOXIC, BIOACCUMULATIVE, PERSISTENT AND UNDERGO LONG-RANGE TRANSPORT

Through the evaluation of scientific studies, the POPRC concluded that both SCCPs and MCCPs are persistent, bioaccumulative, toxic and that they undergo long-range transport.

Studies have shown that that chlorinated paraffins may cause damage to the liver and kidneys, disrupt the endocrine system, cause cancer, and are neurodevelopmental and reproductive toxicants (as reviewed in Wang et al. 2019, Mu et al. 2023, UNEP/POPS/POPRC.11/10/Add.2 & UNEP/POPS/POPRC.18/11/Add.3).

Chlorinated paraffins are also known to be released throughout their life cycle and concentrations of chlorinated paraffins are often higher than other POPs in environmental media (Wong et al. 2017, Lucattini et al. 2018). Humans are exposed through inhalation, dermal contact, dust, and ingestion. Chlorinated paraffins have been detected in human samples, including in serum, milk, nails, hair, and placenta (Krätschmer et al. 2021, Yuan et al. 2022, Mu et al. 2023). Krätschmer et al. (2021) analyzed 57 pooled human milk samples collected during 2012-2019 from 53 countries on five continents and found chlorinated paraffins (CPs) in the pooled samples from all 53 countries, accounting for 18-46% of the total summed POPs in human milk. The researchers reported that "in 43 of 57 pooled samples, MCCP concentrations equalled or exceeded SCCPs." Several studies have shown that the estimated daily intake may approach or exceed the tolerable daily intake (Mu et al. 2023), meaning that the current levels of exposure may be associated with adverse effects on human health. Moreover, studies investigating lower doses than the current estimated tolerable daily intake have indicated adverse effects on the function of internal organs including the liver, thyroid, and kidney (Mu et al. 2023).

Chlorinated paraffins are also found in environmental samples from all over the world (Wei et al. 2016), including in remote locations such as the Arctic (Vorkamp et al. 2019). The concentrations are often higher than for other POPs (Zhou et al. 2016, Vorkamp et al. 2019).

RELATED ONGOING INTERNATIONAL NEGOTIATIONS:

Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention was adopted in 2001 and is an international treaty that aims to eliminate or restrict the production and use of POPs. In 2017 SCCPs were listed for elimination under the Convention. In April 2021 MCCPs were nominated for listing under the Convention. The POPs Review Committee has since gone through the data on MCCPs and in 2022 it concluded that "MCCPs are likely, as a result of their long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted." This conclusion moves MCCPs forward to the last stage of evaluation, the risk management evaluation stage, before the committee will make a recommendation on listing to the conference of the parties.

Basel Convention on the control of transboundary movements of hazardous wastes and their disposal

The Basel Convention entered into force in 1992 and is an international treaty that aims to reduce movements of hazardous wastes between nations, to minimize the rate and toxicity of generated wastes, and to ensure environmentally sound management of wastes.

Low POPs Content Level

When a POPs chemical is listed for elimination under the Stockholm Convention, there remains the problem of how to manage wastes that contain the banned substance. The Basel Convention and the Stockholm Convention together determine how much of a banned POP any waste can contain before it must be managed as hazardous POPs waste. This limit is called the Low POPs Content Level (LPCL).

Intergovernmental Negotiating Committee on a future Plastics Treaty

In March 2022, countries agreed on a historic resolution (5/14) to develop an international legally binding document on plastic pollution, including in the marine environment. The future treaty is currently being negotiated under an international negotiating committee (INC). Plastics consist of chemical monomers, chemical polymers, and chemical additives such as chlorinated paraffins. Throughout the negotiations, many countries have expressed that it is important that the Treaty addresses toxic chemicals in plastics.

CHLORINATED PARAFFINS ARE STILL WIDELY USED AND DETECTED IN PRODUCTS

Although chlorinated paraffins are toxic, persistent, bioaccumulative and of global concern, and SCCPs have been banned since 2017, these chemicals are still widely found in products all over the world, including children's toys. Estimates suggest that between 1930 and 2020, 33 million tons of chlorinated paraffins were produced and used; and 40% by volume still reside in products and will continue to be released into the environment over the coming decades (Chen et al. 2022).

A recent survey of consumer products in Canada showed that SCCPs were present in 84 of 96 products tested, including plastic toys, clothing, electronic devices, and paintings (Kutarna et al. 2023). Similarly, a Belgian survey from 2019 found SCCPs in 27 of 28 products tested (McGrath et al. 2021). They are also frequently found in children's products. In 2017, prior to the global ban, IPEN and ACAT analyzed SCCPs in children's products purchased in ten countries (Miller and DiGangi 2017). Of the analyzed products, 27 (45%) contained SCCPs at concentrations ranging from 8.4 to 19,808 parts per million (ppm). Eighteen percent of the analyzed products exceeded the Stockholm Convention limits on hazardous waste. Another study compared new and old toys bought in Sweden after the 2017 listing and found that the older toys bought in secondhand shops had higher concentrations, often exceeding the EU regulatory limits. Concentrations exceeding legal limits were also found in newer toys (Almroth and Slunge 2022). Similarly, Guida et al (2022) analyzed PVC-based consumer goods in Japan and found that 48% contained SCCPs and MCCPs, including 39 children's toys of which 21 had SCCPs with concentrations up to 12%. Fifteen of the toys had MCCPs with concentrations up to 2.5% (Guida et al. 2022).

After listing SCCPs under the Stockholm convention negotiations on the establishment of a Low POPs Content Level (LPCL) began. The negotiations are ongoing but levels of SCCPs in several toys in the study exceed the health-protective proposal for the LPCL, meaning under the proposed level these toys would be considered hazardous waste.

HOW ARE CHILDREN EXPOSED TO TOXIC CHEMICALS IN TOYS?

Through inhalation of toxic dust

Through inhalation of contaminated air

Skin (dermal) exposure

Ingestion – mouthing or chewing of toys

According to the British Plastics Federation chlorinated paraffins are also found in recycled PVC products (UNEP/POPS/POPRC.19/2), including in products that children come in regular contact with. Studies have shown that tires recycled to make crumb rubber (rubber granulates) used on playgrounds and for infill on artificial turf fields contain chlorinated paraffins (Brandsma et al. 2019).

The wide presence of chlorinated paraffins in children's toys and other products that children come in contact with regularly is particularly troubling given that these chemicals are known to leach out of products (Dong et al. 2020, Wong et al. 2017, Lucattini et al. 2018, Weng et al. 2023). This means that children playing with plastic toys may be exposed to increased levels of chlorinated paraffins due to accumulations of the leached chemicals in dust, leaching upon skin contact (dermal uptake), hand-to-mouth behaviors, and through chewing on the toys (oral exposure). One study investigated exposure pathways of chlorinated paraffins and other flame retardants from toys and found that for children ages three months to six years, hand-to-mouth contact with the toys was the main exposure route to CPs (Zhang et al. 2023). Another study showed that PVC curtains leached chlorinated paraffins into the air and dust with a calculated daily intake of 165 ng/kg/day for adults and 514 ng/kg/day for children. Moreover, the study found that by just touching the curtains once, the dermal (skin) intake could increase by 274 μg (Weng et al. 2023). Another study of exposure pathways showed that toddlers have higher exposures to chlorinated paraffins in dust than adults since they are both exposed through dermal and hand-to mouth contact (Shi et al. 2017). Yuan et al. (2017) found that kitchen hand blenders leak chlorinated paraffins into prepared foods, including MCCPs. The researchers concluded that because CPs leak into prepared foods from hand blenders, consumption of these foods may pose a health risk to infants (Yuan et al. 2017).

AIM AND SCOPE

To determine whether chlorinated paraffins are used in plastic toys sold globally, by testing toys from 10 countries.

METHODS

SAMPLES

In this study, 31 plastic toys purchased in local stores or markets (Figure 1) in ten countries were analyzed for chlorinated paraffins. The toys were soft plastic children's toys such as inflatable bouncing toys, rubber ducks, and dolls and were purchased in Benin, Burundi, Cameroon, Democratic Republic of the Congo, India, Malaysia, Mali, Philippines, Uganda, and USA.

Figure 1 Samples purchasing in Malaysia (CAP Malaysia), Cameroon (CAP Sud) and the Philippines (Ban Toxics).

GC-MS EVALUATION OF CHLORINATED PARAFFINS IN PLASTIC TOYS

The plastic toys were analyzed for the presence of chlorinated paraffins, both SCCPs and MCCPs, in the certified laboratory of the Institute of Food Analysis and Nutrition at the University of Chemistry and Technology in Prague, Czechia.

Sample preparation procedure

The toys were cut into small pieces (diameter approx. 0.5 cm) and then extracted with a solvent mixture of n-hexane:dichloromethane (4:1, v/v). The extract was directly treated by sulphuric acid and the organic phase was extracted, concentrated, and dried under a gentle stream of nitrogen. The resulting sample was then dissolved in isooctane and diluted to a desired concentration.

Instrumental analysis and quantification of chlorinated paraffins

A gas chromatography-mass spectrometry (GC-MS) method was used for the analysis of chlorinated paraffins. An Agilent 7200B system consisting of an Agilent 7890B gas chromatograph equipped with a multimode inlet, PAL RSI 85 autosampler for automated injection, and quadrupole-time of flight mass spectrometer (Q/TOF, Agilent Technologies, Santa Clara, USA) was employed for the analysis.

For the quantification of chlorinated paraffins, as calibration standards of SCCPs, the single-chain standard mixtures were combined to acquire mixtures with final chlorine contents of 45.1, 50.1, 56.1, 60.1, and 65.1% (w/w), respectively. Standard technical mixtures with final chlorine contents of 42.0, 47.0, 53.0, 54.5 and 57.0% were used for the quantification of MCCPs. The limit of quantification (LOQ) was determined as 0.3 µg/g (= 300 ng/g) for SCCPs, 0.75 µg/g for MCCPs and 1.5 µg/g for LCCPs. The data were measured and evaluated according to the laboratory's validated methodology (Tomasko et al. 2021, Tomasko et al. 2023).

RESULTS

CONCENTRATIONS OF CHLORINATED PARAFFINS

Analysis showed that all toys contained SCCPs and MCCPs. SCCP concentrations ranged from 1-60,400 mg/kg. The average concentration was 7,223 and the median 76 mg/kg. For MCCPs concentrations ranged from 1-73,800 mg/kg, with an average of 7,131 and a median of 63 mg/kg (See Annex 1 for raw data).

Of the 31 plastic toys, nine were dolls. Among those, the combined concentrations of SCCPs and MCCPs ranged between 3-1,273 mg/kg. The highest concentrations were in the plastic dolls purchased in Burundi (1,273 mg/kg) and the Democratic Republic of Congo (1,204 mg/kg) (Figure 2).

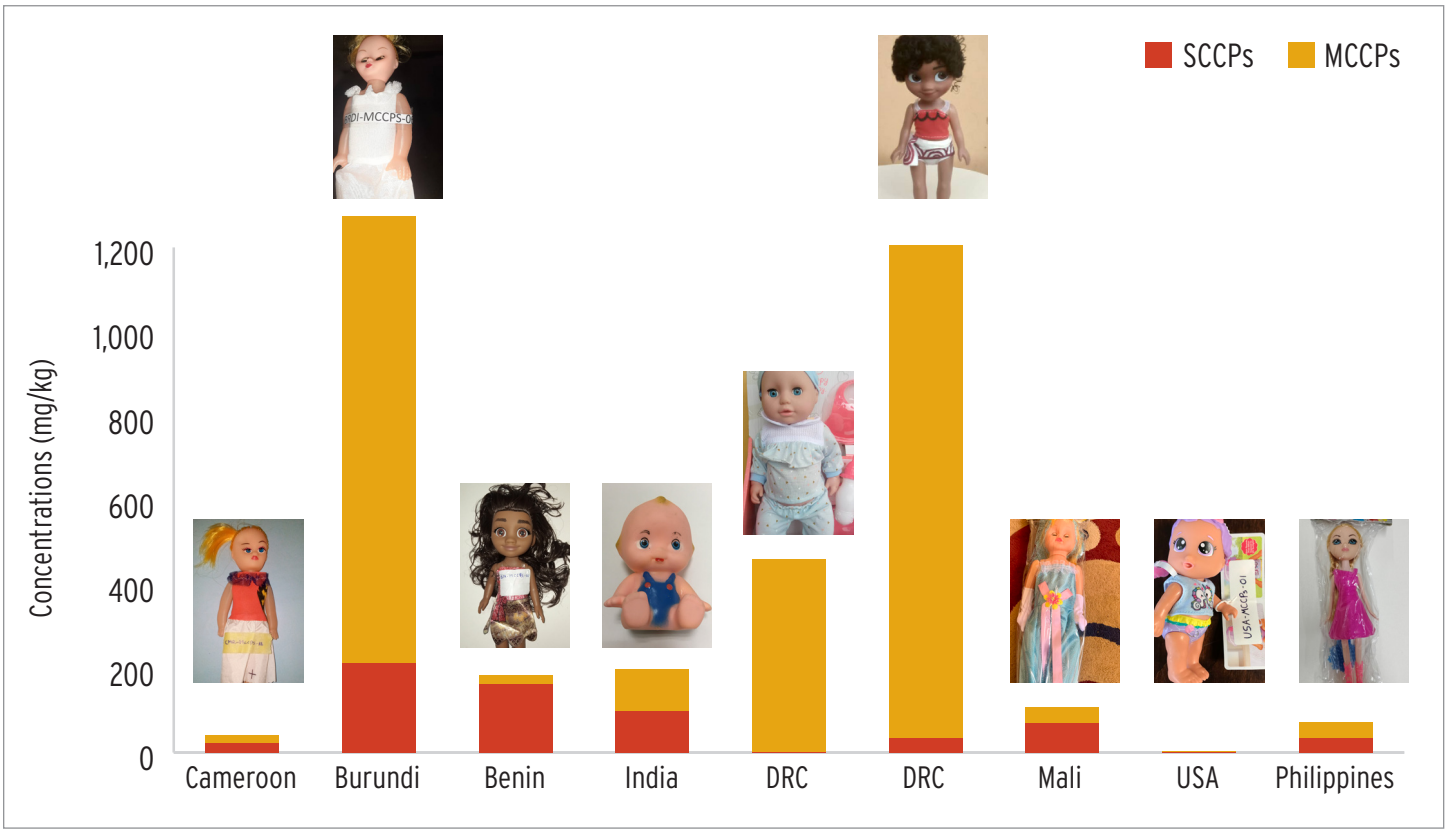


Figure 2 Concentrations (mg/kg) of SCCPs and MCCPs in dolls purchased in eight different countries.

Another nine samples were plastic ducks, with the combined SCCPs and MCCPs concentrations ranging between 6-40,400 mg/kg (Figure 3). The highest concentration was in the duck purchased in Benin (40,400 mg/kg).

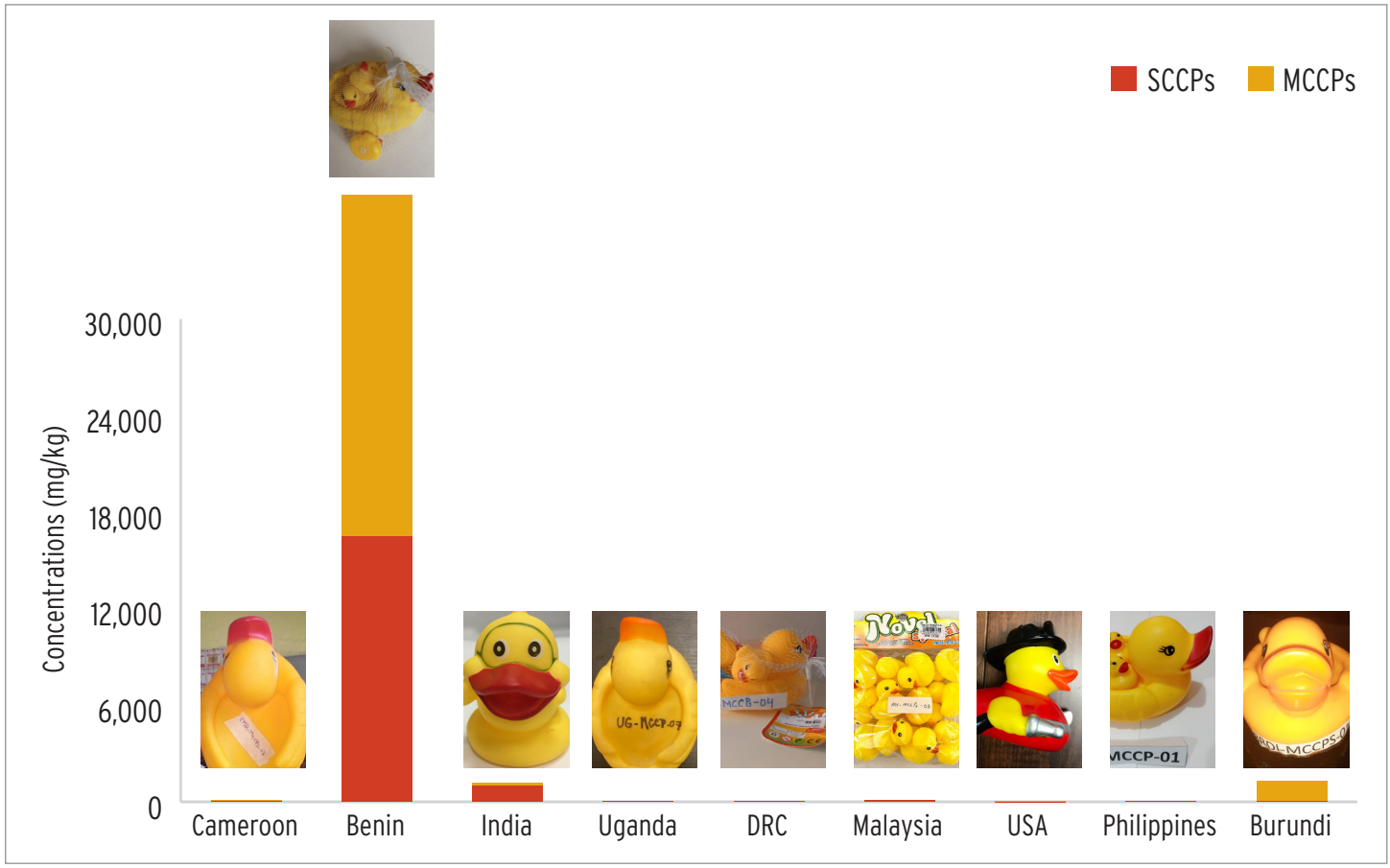


Figure 3 Concentrations (mg/kg) of SCCPs and MCCPs in rubber ducks purchased in 9 different countries

Five of the analyzed toys were inflatable plastic bouncing toys. We found that this group of toys had the highest concentrations of both SCCPs and MCCPs (Figure 4). The combined concentrations ranged between 48,800 and 91,700 mg/kg.

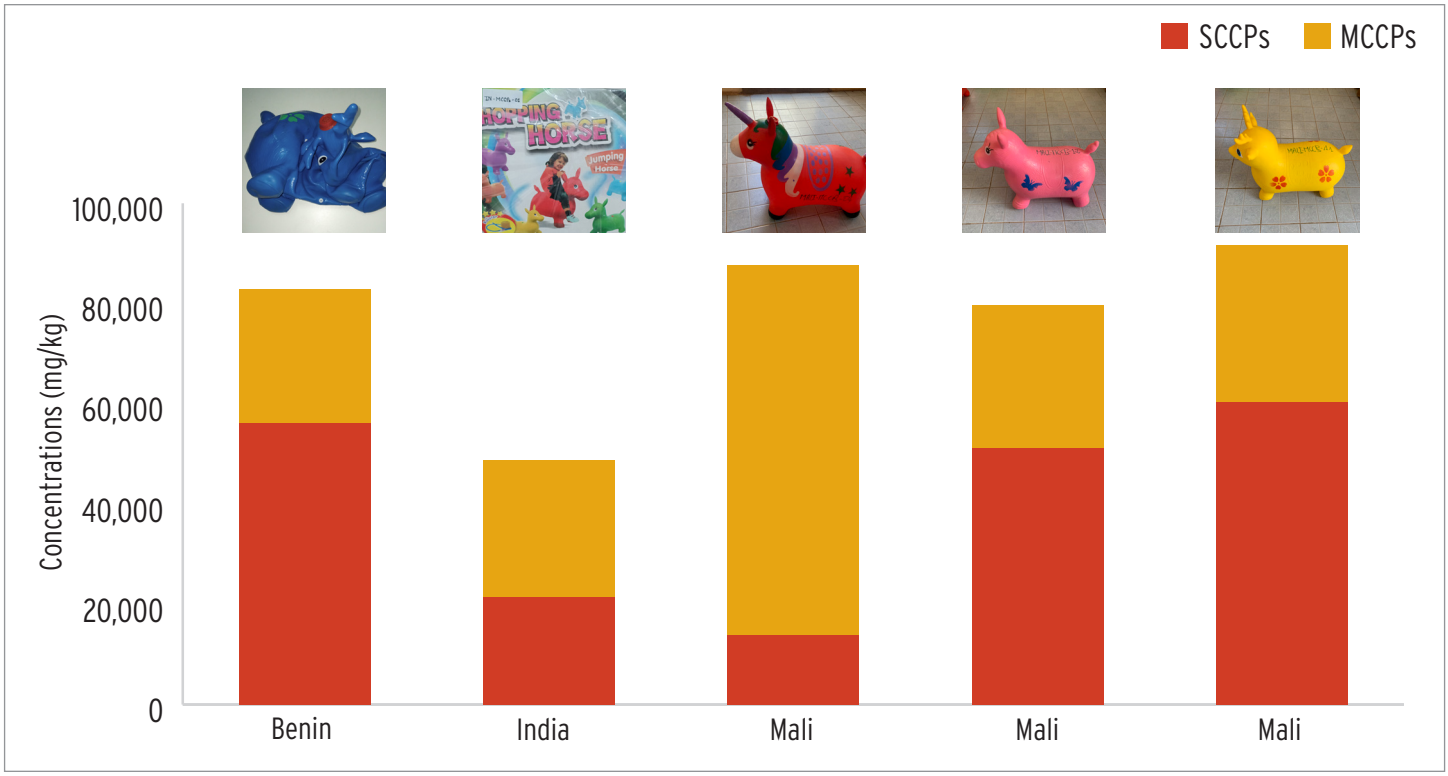


Figure 4 Concentrations (mg/kg) of SCCPs and MCCPs in inflatable toys purchased in three different countries

The other eight toys were a mix of different types of soft plastic toys: one ball, one bear, one pair of rubber boots, one frog, one lizard, two bath rings, and one baby toy (Figure 5).

Fifteen of the 31 toys were also analyzed for LCCPs. Of those, three contained LCCPs above the limit of quantification. Two of those were samples purchased in Mali and the third was a sample of baby toys purchased in Malaysia (Figure 6).

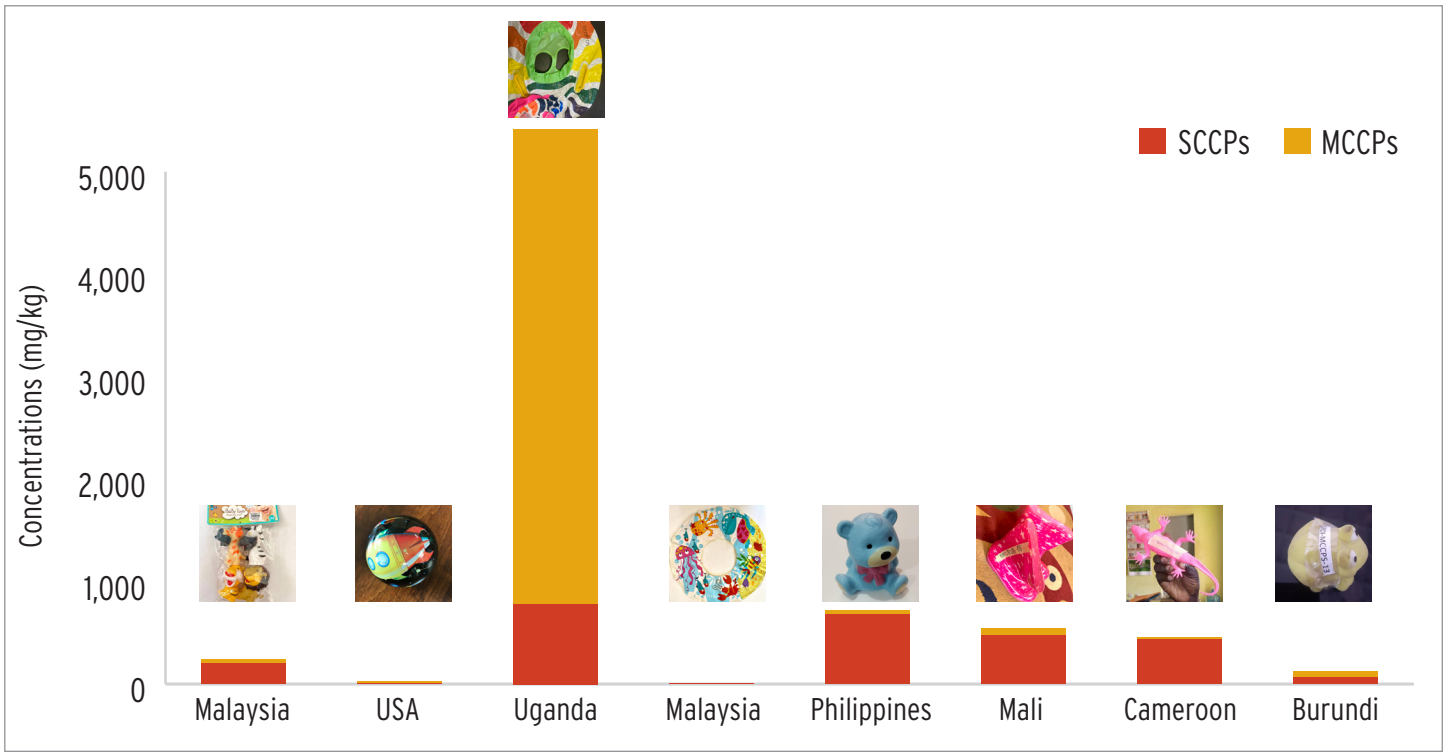


Figure 5 Concentrations (mg/kg) of SCCPs and MCCPs in other plastic toys purchased in seven countries.

Figure 6 Concentrations of LCCPs in the 3/15 samples that had concentrations above LOQ.

CHAIN LENGTHS AND CHLORINATION LEVELS

The compositions of the SCCPs and MCCPs were analyzed for 24 of the samples (Raw data in Annex 2).

For SCCPs, the chain lengths were rather evenly distributed with an average of 27% C10, 26% C11, 19% C12 and 28% C13 (Figure 7a). Chlorination levels were dominated by CL6 (38%) and CL7 (30%) (Figure 7b).

For MCCPs, the average chain lengths were dominated by C14, which is in line with estimates made by the Environment Agency (2019a) and Wang et al (2018). Average chlorination levels were dominated by CL6 (23%) and CL7 (27%) and Cl8 (27%) (Figure 8).

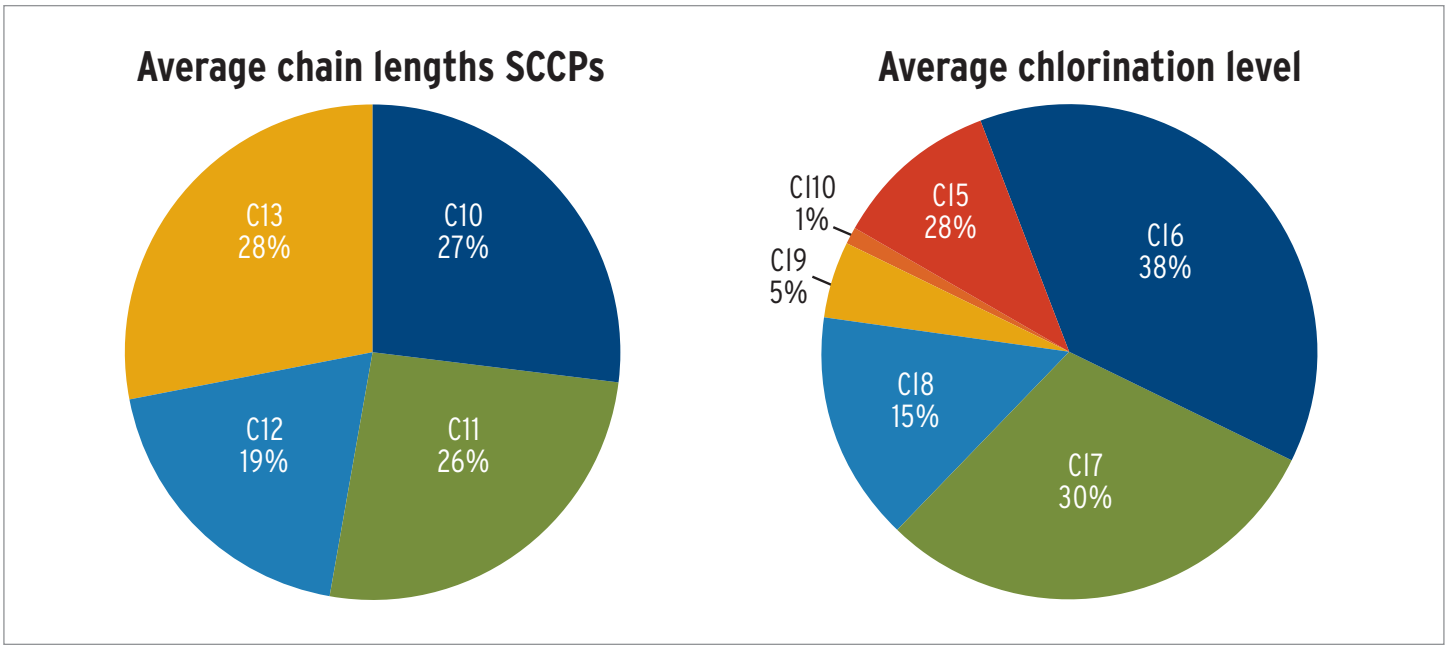


Figure 7 a) Average chain lengths and b) chlorination level for SCCPs (n=24)

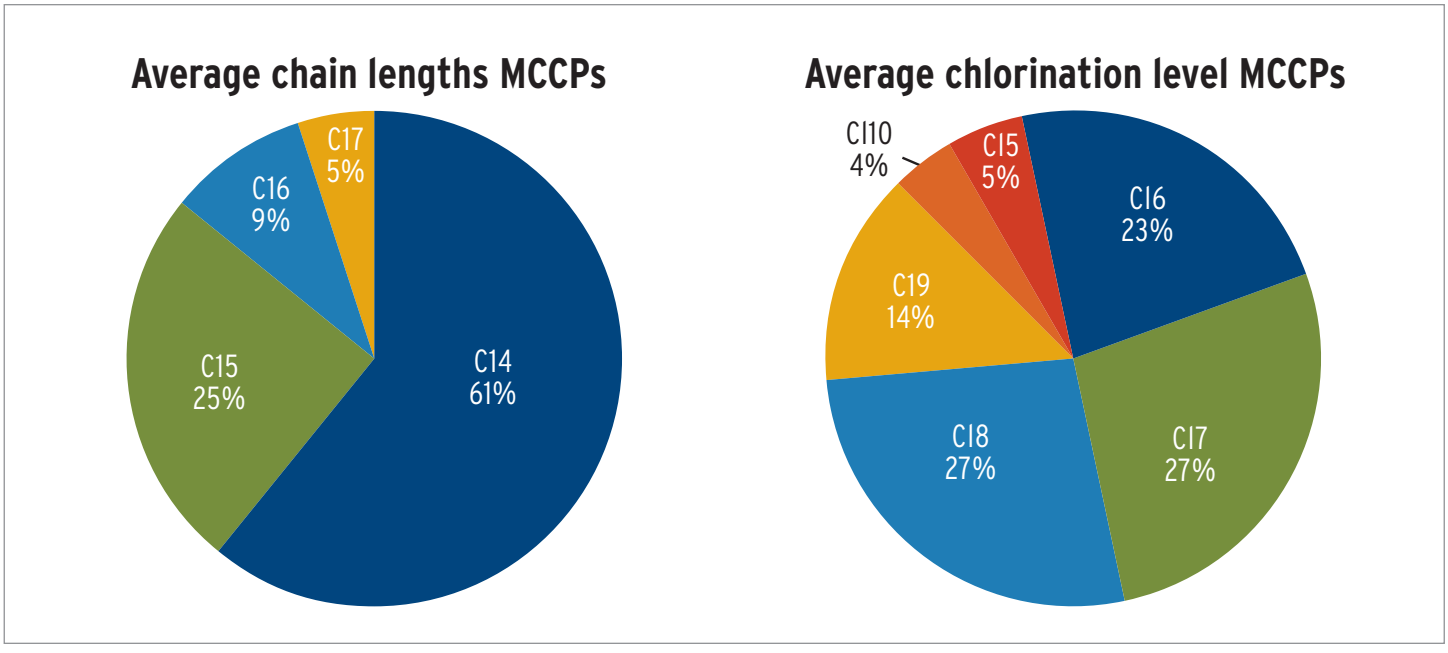


Figure 8 a) Average chain lengths and b) chlorination level for MCCPs (n=24)

DISCUSSION

Although SCCPs were listed for global elimination in 2017 without any exemptions for toys, all the analyzed toys in this study purchased five years after the listing contained SCCPs.

The decision text for SCCPs under the Stockholm Convention notes that mixtures of chlorinated paraffins can contain up to 1% of unintentionally added SCCPs. In all but one of the samples analyzed in this study, SCCPs made up more than one percent of the total concentration of MCCPs and SCCPs. The average percentage of SCCPs was 48% and the maximum was 94%. These comparable concentrations of MCCPs and SCCPs indicate that the presence of the banned class of SCCPs is not due to contamination but that SCCPs were intentionally added to the toys. All of the toys also contained MCCPs which are currently being evaluated under the Stockholm Convention.

Moreover, the inflatable toys had such high concentrations that 5-9 % of the weight of the toys consists of chemicals that are so toxic that they are already banned globally (SCCPs) or that are being evaluated to determine whether they should be banned globally (MCCPs).

These findings correspond with findings from previous studies (McGrath et al. 2021, Almroth and Slunge 2022, Guida et al. 2022, Kutarna et al. 2023) showing widespread continued use of chlorinated paraffins.

The results highlight several gaps in how toxic chemicals are currently regulated:

1. highlight the importance of regulating classes of chemicals to prevent replacing one toxic chemical with another (so-called "regrettable substitutions);
2. demonstrate the harm of allowing exemptions for continued use of toxic chemicals; and
3. show the importance of transparency and traceability of chemicals used in plastics.

CLASSES OF CHEMICALS

This study of chlorinated paraffins demonstrates why it is so important to regulate chemical classes instead of individual chemicals to prevent substitution with substances that have similar or more hazardous properties. As an example, polychlorinated biphenyls (PCBs) were widely used in plastics but were listed for global elimination in 2001. SCCPs were then substituted for some applications of PCBs, but then they were also listed as banned POPs. Now other chlorinated paraffins, including MCCPs and LCCPs that are just as toxic are used as substitutes of SCCPs.

The number of congeners of chlorinated paraffins has been theoretically calculated to be around one billion (Darnerud and Bergman 2022). This includes SCCPs, MCCPs, LCCPs and chlorinated paraffins that fall outside of the SCCPs, MCCPs and LCCPs ranges, such as those known as very short-chain chlorinated paraffins (vSCCPs) and very long-chain chlorinated paraffins (vLCCPs). It is likely that these CPs share similar harmful properties and data demonstrate that vSCCPs are also found in commercial products and in wildlife and have shown bioaccumulation tendency (Zhou et al. 2019).

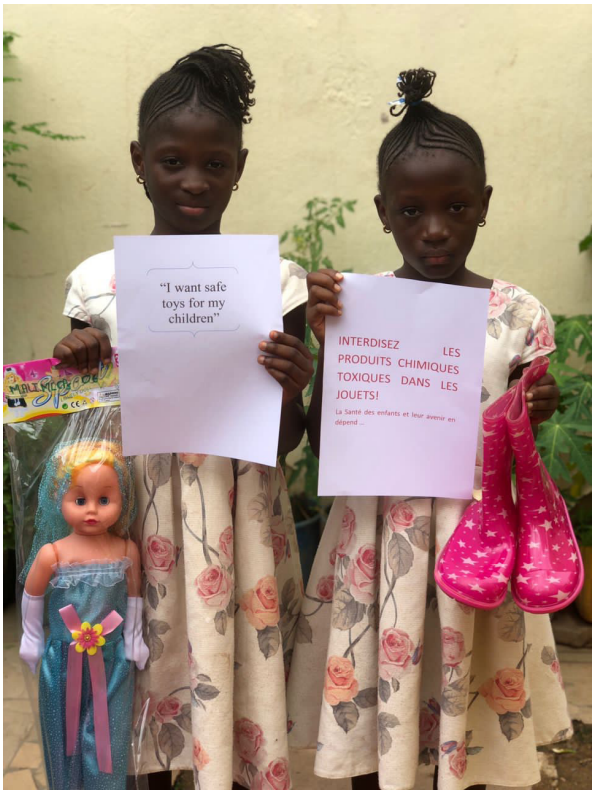
In this study 3 of 15 analyzed toys contained LCCPs. Although there are fewer data on LCCPs, they share similar properties as other chlorinated paraffins. They are very persistent, (Yuan et al. 2017) they are found in breastmilk (Bergman et al. 2022), and are frequently detected in environmental samples, including biota of the Arctic (Yuan et al. 2021). In German environmental samples, LCCPs have increased by 290% over the past 25 years, with concentrations of LCCPs exceeding those of the other CPs in 40% of the biota samples. (Yuan et al. 2022).

Studies on the toxicity of LCCPs are more scarce than for the other chain lengths (Chen et al. 2023), however studies have indicated that they have higher binding affinity than other chain lengths (Sprengel et al. 2021). Studies have also shown that LCCPs increase liver weight (Nilsen et al. 1981), cause inflammatory response (Ren et al. 2019), cause oxidative stress, and are endocrine disruptors (Ren et al. 2019). Given that LCCPs and other chlorinated paraffins fall outside the narrow definitions of SCCPs and MCCPs, there is a high risk of continued problems with regrettable substitution.

This toxic substitution pattern is not limited to CPs but has been a frequent industry ploy to evade regulations for decades. Another example is Dechlorane Plus (DP), a flame-retardant chemical listed under the Stockholm Convention in 2023. DP was used as a replacement for DecaBDE, another flame-retardant chemical that was listed in 2017. Similarly, several subgroups of PFAS, the large group of chemicals often referred to as "forever chemicals" have been listed under the Convention and often replaced with other subgroups in the larger class of PFAS. This highlights the importance of preventing regrettable substitutions. For many chemicals toxic substitutions can be avoided through regulations that address larger chemical groups, rather than taking years or decades to regulate each individual chemical in the group one by one.

In a few cases, the Stockholm Convention has included certain classes of chemicals and/or their related substances in listings, such as dioxins and furans, PCBs, PBDEs, chlorinated napthalenes, PFOS, SCCPs, and PFOA. But this has not been a consistent practice and when applied, the regulated groups are not comprehensive. The nominations are often too narrow, as illustrated with chlorinated paraffins and PFAS, resulting in continued risks for human health and the environment. Nonetheless, these are precedents and show a necessity for a class-based approach for CPs and many other chemical groups. Failing to adopt a class-based approach causes an unnecessary additional workload under the Stockholm Convention, requiring evaluation of the extended group of chemicals already listed which could have been included in the original nominations.

This problem has also been highlighted for the ongoing negotiations of a future Plastics Treaty. The resolution for the Treaty (5/14) highlights the importance of addressing plastic pollution throughout the life cycle (UNEP/PP/OEWG1/INF/1). Since plastics are a combination of chemicals and carbon derived from fossil fuels, regulating the use of chemicals in plastics will be a key component needed to protect human health and the environment from plastic pollution. Several documents have highlighted the need to address chemical classes used in plastics (UNEP 2023, BRS 2023, IPEN 2023). Given that over 13,000 chemicals are used in plastics (UNEP 2023), a class-based approach would not only be more efficient, but it would also decrease the risk of substituting one toxic chemical with another and therefore would be a better approach for protecting human health and the environment.


"I want safe toys for my children"
INTERDISEZ LES PRODUITS CHIMIQUES TOXIQUES DANS LES JOUETS!


« Interdisez les produits chimiques toxiques dans les jouets des enfants ! »
INTERDISEZ LES PRODU
CHIMIQUES TOXIQUE
DANS LES JOUETS!


खिलौनों में जहरीले रसायनों पर प्रतिबन्ध लगाओ ।


BAN TOXICS
BAN TOXIC CHEMICALS IN TOYS!
BAN TOXICS
ITIGIL ANG PAGLAGAY NG NAKALALASONG KEMIKAL SA MGA LARUANG PAMBATA


Circus Animal
3+


Ban toxic chemicals in toys.

CAUTIONARY TALE OF EXEMPTIONS

When SCCPs were listed under the Stockholm Convention the listing included several exemptions, including allowing continued use in PVC. The exemption specifically states that it does not apply to the use of SCCPs in toys, however here we see that the chemical is still widely found in toys bought in stores five years after it was listed under the Convention.

USA and Malaysia are not parties to the Convention and India has not ratified the amendment adding SCCPs to Annex A. For the others, the decision came into effect on the 18/12/2018 (Stockholm Convention 2023). It is also important to note that although there are specific exemptions listed for SCCPs, only Vietnam has registered for specific exemptions.

The widespread and continued presence of SCCPs in the environment and products has also been further confirmed in other studies (McGrath et al. 2021, Almroth and Slunge 2022, Guida et al. 2022, Kutarna et al. 2023). It is likely that the exemption for use in PVC contributes to the continued widespread use of SCCPs. The findings in this report should be seen as a cautionary tale and warning of the risk of uncontrollable and widespread use if exemptions are allowed for chemicals listed under the Stockholm Convention.

This is especially important as greater numbers of exemptions have been allowed for recent listings. The Stockholm Convention was adopted in 2001 and entered into force in 2004. During the first decade (2001-2011), 18 chemicals or chemical classes were listed in Annex A. During the second (2012-2022), 8 chemicals or groups of chemicals were listed. While the number of listings were lower in the second decade, the percentage of listings that included exemptions have increased. During the first decade, only DDT had exemptions for production, corresponding to 6% of the listings during that period. Another three had limited exemptions for use, corresponding to 22% of the listings. During the second decade 63% (5/8) of the listed chemicals or groups of chemicals had exemptions for production and use (Figure 9).

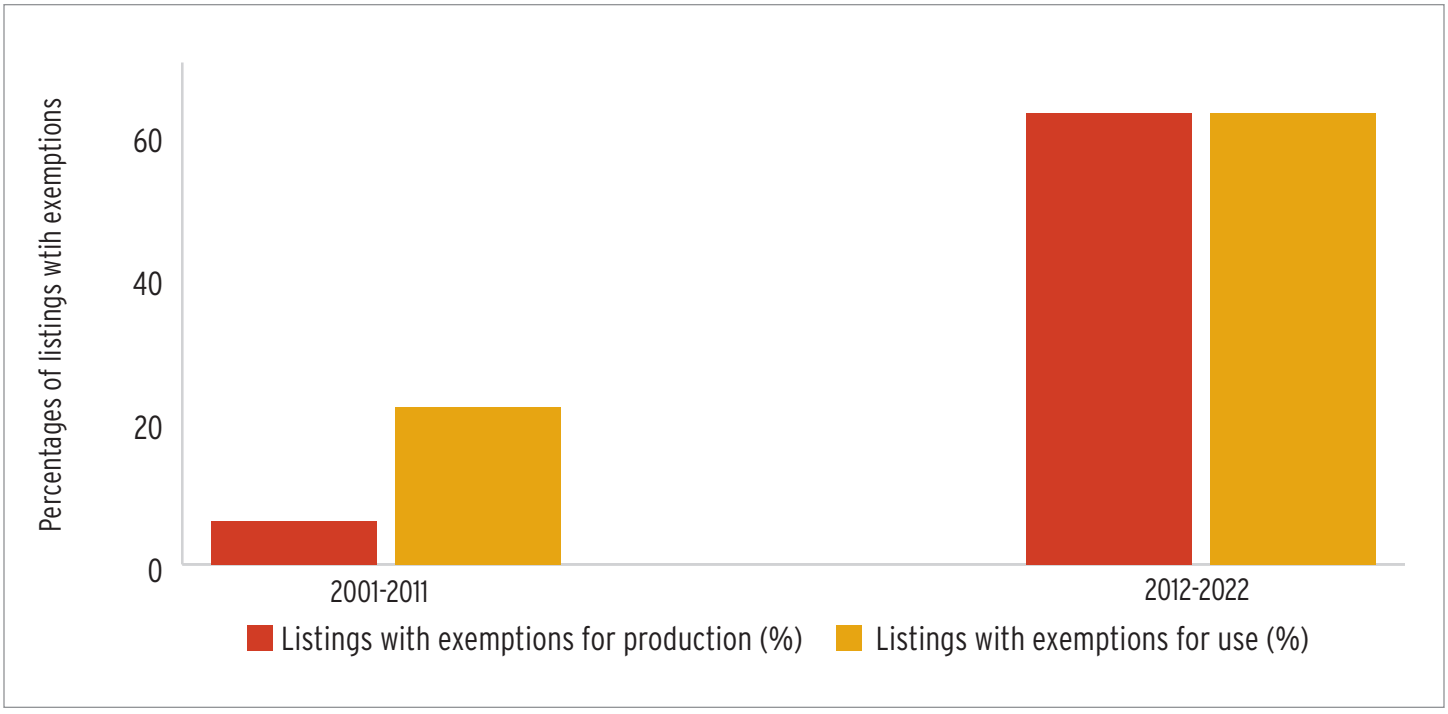


Figure 9 Percentage of listings in Annex A of the Stockholm convention that were listed with specific exemptions during 2001-2011 compared to 2012-2022

The time limit for exemptions has also increased. Although Article 4 of the Convention specifies that time-limited exemptions may be provided for five years, recent listings have included exemptions that extend for over two decades (Figure 10).

Parties to the Convention often allow an expansive list of exemptions at the request of industry or Parties without adequate justification or narrowing of the scope of these exemptions. These exemptions come at a price for human health and the environment. The persistent nature of these chemicals means that the continued use and production will lead to continued accumulation in wastes and in the environment that will pose threats long after the exemptions expire. It is crucial that any exemptions granted for listed substances are as narrow as possible and only allowed for a short period of time. This promotes the development of alternatives and ensures that the Convention fulfils its purpose of global elimination of POPs.

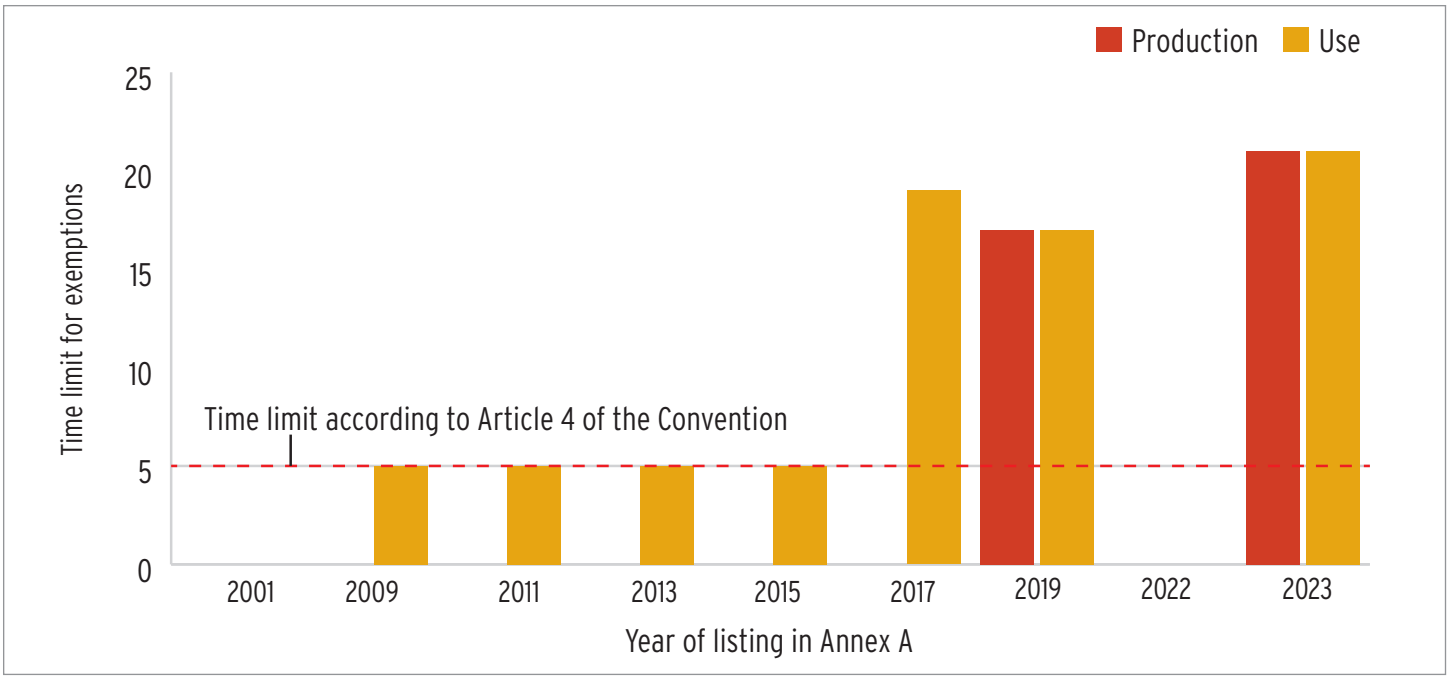


Figure 10 Timespan for specific exemptions of chemicals listed in Annex A of the Stockholm Convention.

TRANSPARENCY AND TRACEABILITY

Chemicals in plastics have been remarkably void of rules regarding transparency, making it impossible for consumers and waste managers to know which plastic products contain toxic chemicals. For POPs listed under the Stockholm Convention, there are provisions that require the identification of POPs in products and articles. The text of the Convention states that each Party shall "Develop appropriate strategies for identifying [...] products and articles in use and wastes consisting of, containing or contaminated with a chemical listed in Annex A, B or C."

Moreover, the importance of being able to identify listed POPs throughout the supply chain is discussed in the risk management profiles (e.g. Dechlorane Plus, UV-328) and the listing decisions (e.g. hexabromocyclododecane (HBCD), pentachlorophenol (PCP)).

For decaBDE, another chemical listed under the Stockholm Convention, the EU POPs Regulation (2019/1021) states that "articles in which decaBDE is used shall be identifiable by labeling or other means throughout its life cycle." Similarly, hexabromocyclododecane in expanded polystyrene placed on the market after 2016 should be identifiable "by labeling or other means throughout its life cycle." Toys in this study had no labeling or other means of identification that would indicate the presence of POPs, even though they all contained listed chemicals.

Our study and other similar ones highlight the need for and enforcement of labeling of articles containing POPs, particularly children's and other household products.

There are several ways of identification in place today for chemicals in plastic articles, including labeling and databases. For example, Hewlett Packard (HP) has internal standards for how to label different plastics as well as certain phthalates and flame retardants that are used in plastic pieces that weigh more than 25 grams (HP 2023). Another example is the Global Automotive Declarable Substance List (GADSL), a voluntary initiative within the automotive supply chain in which substances of concern are tracked.5 In the EU, the SCIP (Substances of Concern in Products) database catalogues articles that contain chemicals that are included on the list of substances of very high concern (SVHC) on the candidate list under REACH. According to the Waste Framework Directive (2008/98/EC) and beginning in 2021, manufacturers, importers or distributors are required to provide information about articles released on the EU market that contain these chemicals at or above 0.1 % of weight (ECHA 2023).

Increased transparency of the use of chemicals is a crucial tool to allow actors throughout the value chain to protect workers, communities, and consumers from potential risk.

TOYS OR HAZARDOUS WASTES?

As noted above, the measured concentrations in this study are so high that several of the toys would be classified as hazardous wastes according to the current proposed low POPs content levels (LPCLs) under the Basel Convention.

The low POPs content for SCCPs is still being negotiated. Environmental and health advocates have argued for a concentration limit of 100 mg/kg, whereas industry proponents have argued for a significantly higher limit of 10,000 mg/kg. This higher limit is not protective given that recent research has shown that even concentrations below the current estimated tolerable daily intake have indicated potential damage to internal organs (Mu et al. 2023), indicating that harmful concentrations are likely much lower than previously thought. The lower POPs content is therefore the only reasonable option in order to ensure safety of workers' health and the environment.

Regardless of concentration values that are ultimately adopted, several of the toys had higher concentrations than even the higher values, meaning that they would be identified as hazardous wastes under any proposal. Of the tested toys, 19% (6/31) had concentrations of SCCPs over 10,000 mg/kg and 48% (15/31) had concentrations surpassing 100 mg/kg. Ten of the toys also had concentrations that were above Sweden's proposal for MCCPs in electronics (0.1%).

These results further highlight the lack of transparency or labelling associated with toxic chemicals in plastics. This has consequences throughout the life cycle, including at the waste management stage with consequences for waste workers as well as local communities. Studies have shown that e-waste workers have been shown to be exposed to high concentrations of chlorinated paraffins (Chen et al. 2018) and that chlorinated paraffins accumulate in local plants and animals near e-waste facilities (Luo et al. 2015, Chen et al. 2018).

The lack of labeling also has consequences for recycling. The Stockholm Convention prohibits the recycling of products that contain SCCPs. Studies have however shown that reuse and recycling are re-introducing SCCPs into the market and into homes (Brandsma et al. 2019, Almroth and Slunge 2022). The lack of transparency throughout the life cycle of POPs chemicals shifts the burden of proof to waste management where the cost of testing is high, instead of ensuring a transparent flow of information throughout the life cycle from production, transportation, use, and disposal.

CONCLUSIONS AND RECOMMENDATIONS

Chlorinated paraffins are some of the highest production volume chemicals in the world. Due to their toxicity, persistence, bioaccumulation and propensity for long-range environmental transport they are also some of the world's most dangerous chemicals, affecting human health and the environment globally. A subclass of CPs have already been banned (SCCPs), and another subclass (MCCPs) are under evaluation for a potential ban. Research shows that current exposure levels may exceed the tolerable daily intake and that people are exposed through food, household dust, and products. Exposure levels pose greater risks to vulnerable populations including children, pregnant women, and workers.

This study found alarmingly high concentrations of both the banned subclass and the currently evaluated subclass of CPs in children's toys. All toys had chlorinated paraffins and many had levels so high that they would be considered hazardous wastes.

These results highlight the urgency of regulating these chlorinated paraffins globally and across regulatory frameworks. To protect human health and the environment we recommend the following:

STOCKHOLM CONVENTION

- Ensure that Article 6 is implemented through labeling and other means of identification that makes it possible to trace the use of POPs throughout their life cycle for producers, retailers, users, waste managers.
- Chemicals should be listed without exemptions. If an exemption is truly critical for the functioning of society, those exemptions should only be granted for narrow, clearly defined applications and for short terms.
- Regulate classes of chemicals to avoid regrettable substitution.
- List MCCPs in Annex A without exemptions.

BASEL CONVENTION

- Adopt 100 mg/kg as the Low POPs Content Level allowable for SCCPs.

PLASTICS TREATY

- End the production and use of toxic chemicals in plastics.
  - Ban chlorinated paraffins as a class, given that they all have similar concerns.
- Ban recycling of plastics containing hazardous chemicals.
- Ensure the public's right to know about chemicals in plastics.

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PHOTOS PROVIDED BY IPEN PARTICIPATING ORGANIZATIONS INVOLVED IN THE PREPARATION OF THE REPORT.

ANNEX I

CONCENTRATIONS OF CHLORINATED PARAFFINS

COUNTRY	TYPE OF TOY	SCCP	MCCP	LCCP
		MG/KG	MG/KG	MG/KG
Cameroon	Doll	21,9	19,1	n/a
Cameroon	Duck	27,8	80,7	n/a
Cameroon	Lizard	437	19,1	n/a
Burundi	Ducks	52,6	1,240	n/a
Burundi	Doll	213	1,060	n/a
Burundi	Drog	59,6	63,0	n/a
Benin	Duck	16,500	23,900	n/a
Benin	Doll	162	22,9	n/a
Benin	Bouncing Toy	56,100	26,800	n/a
India	Bouncing toy	21,500	27,300	n/a
India	Duck	982	194	n/a
India	Doll	99,0	97,5	n/a
Mali	Bouncing toy	13,900	73,800	n/a
Mali	Bouncing toy	51,100	28,500	n/a
Uganda	Duck	2	57	n/a
Uganda	Bathring	781	4,630	n/a
DRC	Doll	2	458	<1.5
DRC	Duck	10	6	<1.5
DRC	Doll	34	1,170	<1.5
Mali	Doll	70	37	<1.5
Mali	Bouncing toy	60,400	31,300	1600
Mali	Boots	470	74	4.4
Malaysia	Baby toys	197	48	1.8
Malaysia	Duck	76	57	<1.5
Malaysia	Bathring	2	1	<1.5
USA	Doll	2	1	<1.5
USA	Duck	1	4	<1.5
USA	Ball	7	20	<1.5
Philippines	Duck	2	4	<1.5
Philippines	Doll	34	37	<1.5
Philippines	Bear	675	46	<1.5

ANNEX II

KEY	
COUNTRY	ABBREVIATION
Democratic Republic of the Congo	DR
Mali	MA
Malaysia	MY
Philippines	PH
Cameroon	CM
Burundi	BI
Benin	BJ
India	IN
Uganda	UG

COMPOSITION OF CHLORINATED PARAFFINS

	DR	DR	MA	MA	MA	MY	MY	PH	PH	CM	CM	CM	BI	BI	BI	BJ	BJ	BJ	IN	IN	IN	MA	MA	UG
C10 Cl5	2%	2%	16%	2%	1%	8%	2%	1%	2%	8%	2%	6%	2%	2%	6%	1%	19%	3%	2%	4%	3%	2%	4%	0%
C10 Cl6	18%	14%	19%	4%	6%	21%	10%	7%	8%	27%	13%	25%	7%	7%	17%	10%	20%	8%	8%	17%	13%	8%	11%	1%
C10 Cl7	8%	3%	5%	2%	4%	9%	6%	6%	8%	12%	9%	16%	5%	4%	9%	11%	6%	4%	5%	13%	11%	7%	6%	2%
C10 Cl8	2%	1%	1%	1%	1%	1%	2%	2%	2%	2%	3%	2%	1%	1%	2%	3%	1%	1%	1%	3%	13%	2%	1%	2%
C10 Cl9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	0%	0%	1%
C10 Cl10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%
C11 Cl5	1%	1%	9%	3%	2%	6%	3%	1%	5%	5%	2%	4%	2%	0%	0%	0%	14%	5%	3%	2%	2%	2%	5%	0%
C11 Cl6	9%	2%	13%	8%	10%	16%	11%	6%	4%	12%	9%	17%	8%	11%	12%	9%	15%	15%	12%	11%	5%	9%	15%	3%
C11 Cl7	12%	3%	6%	4%	7%	8%	8%	8%	5%	7%	10%	10%	7%	9%	7%	12%	4%	9%	9%	11%	3%	8%	9%	9%
C11 Cl8	6%	1%	2%	1%	2%	2%	3%	4%	8%	2%	6%	2%	3%	2%	3%	5%	1%	2%	3%	3%	6%	4%	2%	10%
C11 Cl9	1%	0%	0%	0%	0%	0%	1%	1%	2%	0%	2%	0%	1%	0%	1%	1%	0%	0%	0%	1%	7%	1%	0%	6%
C11 Cl10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%	0%	1%
C12 Cl5	0%	0%	3%	3%	2%	3%	2%	1%	3%	2%	1%	1%	1%	3%	0%	0%	3%	2%	2%	1%	1%	2%	3%	0%
C12 Cl6	3%	0%	6%	8%	11%	9%	8%	5%	7%	5%	4%	5%	8%	12%	6%	6%	4%	9%	11%	8%	2%	9%	11%	0%
C12 Cl7	3%	0%	6%	5%	9%	5%	7%	9%	10%	2%	9%	3%	9%	9%	8%	10%	3%	7%	9%	8%	2%	8%	8%	1%
C12 Cl8	2%	0%	1%	2%	4%	1%	2%	5%	8%	3%	6%	1%	6%	3%	3%	7%	1%	2%	4%	4%	2%	4%	3%	1%
C12 Cl9	1%	0%	0%	0%	1%	0%	1%	2%	2%	1%	2%	0%	1%	1%	1%	2%	0%	0%	1%	1%	3%	2%	1%	1%
C12 Cl10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%
C13 Cl5	1%	3%	2%	7%	2%	1%	4%	4%	1%	1%	0%	1%	1%	3%	0%	0%	2%	3%	2%	0%	0%	2%	2%	0%
C13 Cl6	8%	15%	4%	23%	12%	4%	13%	15%	6%	5%	4%	2%	9%	14%	8%	4%	3%	13%	10%	4%	2%	10%	9%	6%
C13 Cl7	12%	22%	3%	16%	14%	2%	10%	12%	7%	5%	7%	1%	13%	10%	9%	7%	2%	10%	8%	5%	2%	9%	6%	13%
C13 Cl8	8%	18%	1%	7%	9%	1%	5%	7%	5%	3%	7%	1%	9%	6%	7%	7%	1%	5%	5%	3%	1%	7%	4%	21%
C13 Cl9	3%	10%	0%	2%	3%	0%	2%	3%	3%	1%	3%	0%	5%	2%	2%	3%	0%	1%	2%	1%	1%	3%	1%	15%
C13 Cl10	0%	3%	0%	0%	1%	0%	0%	1%	1%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	6%

ANNEX II, CONTINUED

COMPOSITION OF CHLORINATED PARAFFINS

	DR	DR	MA	MA	MA	MY	MY	PH	PH	CM	CM	CM	BI	BI	BI	BJ	BJ	BJ	IN	IN	IN	MA	MA	UG
C14 Cl5	4%	2%	14%	9%	3%	6%	6%	3%	9%	9%	0%	2%	0%	1%	1%	0%	0%	4%	3%	2%	0%	3%	2%	3%
C14 CL6	16%	14%	27%	29%	16%	15%	21%	15%	20%	26%	14%	13%	18%	11%	7%	13%	4%	15%	15%	10%	12%	13%	9%	14%
C14 CL7	15%	27%	17%	22%	22%	14%	19%	23%	16%	25%	10%	17%	22%	12%	12%	20%	12%	10%	14%	11%	20%	19%	9%	12%
C14 CL8	20%	30%	14%	10%	18%	14%	13%	33%	13%	20%	0%	15%	26%	10%	18%	22%	15%	35%	9%	8%	24%	19%	7%	9%
C14 CL9	13%	21%	5%	3%	8%	4%	4%	19%	7%	10%	6%	5%	12%	4%	16%	9%	9%	9%	3%	4%	10%	10%	4%	4%
C14 CL10	2%	6%	1%	0%	2%	1%	1%	6%	2%	3%	1%	1%	0%	1%	8%	2%	2%	2%	1%	1%	3%	3%	1%	1%
C15 CL5	1%	0%	3%	3%	1%	2%	3%	0%	3%	0%	0%	2%	0%	2%	1%	0%	0%	0%	2%	1%	0%	0%	1%	1%
C15 CL6	4%	0%	6%	9%	4%	6%	9%	0%	5%	1%	9%	10%	0%	13%	4%	4%	2%	5%	9%	5%	5%	5%	7%	7%
C15 CL7	8%	0%	5%	8%	7%	7%	9%	0%	6%	1%	11%	13%	0%	17%	4%	7%	7%	6%	10%	7%	0%	7%	9%	8%
C15 CL8	8%	0%	4%	4%	6%	6%	5%	0%	6%	1%	8%	11%	10%	13%	3%	8%	10%	5%	7%	5%	10%	8%	8%	6%
C15 CL9	5%	0%	2%	1%	3%	3%	2%	0%	4%	1%	4%	4%	6%	5%	2%	4%	8%	3%	2%	3%	7%	5%	4%	3%
C15 CL10	1%	0%	0%	0%	1%	1%	0%	0%	2%	0%	1%	1%	0%	1%	0%	1%	3%	1%	0%	1%	0%	2%	1%	1%
C16 CL5	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	1%	0%	0%	1%	1%
C16 CL6	0%	0%	1%	1%	1%	4%	1%	0%	1%	1%	7%	2%	0%	2%	3%	0%	1%	2%	5%	6%	0%	1%	4%	6%
C16 CL7	1%	0%	1%	1%	2%	4%	1%	0%	1%	0%	7%	2%	0%	1%	3%	2%	4%	0%	6%	8%	5%	1%	5%	6%
C16 CL8	1%	0%	0%	0%	2%	3%	1%	0%	1%	0%	3%	2%	6%	1%	2%	2%	6%	2%	4%	7%	5%	1%	5%	5%
C16 CL9	1%	0%	0%	0%	1%	3%	1%	0%	1%	0%	0%	1%	0%	0%	1%	3%	6%	0%	2%	4%	0%	1%	3%	2%
C16 CL10	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	2%	0%	0%	1%	0%	0%	1%	1%
C17 CL5	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	2%	1%	0%	0%	0%	0%	1%	0%	0%	1%	1%
C17 CL6	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	4%	0%	0%	3%	4%	0%	0%	0%	2%	3%	0%	1%	4%	3%
C17 CL7	0%	0%	0%	0%	1%	2%	1%	0%	0%	0%	5%	0%	0%	1%	4%	0%	2%	0%	3%	5%	0%	1%	6%	3%
C17 CL8	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	4%	0%	0%	0%	2%	1%	2%	1%	2%	4%	0%	1%	4%	2%
C17 CL9	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	2%	0%	0%	0%	1%	0%	3%	0%	1%	3%	0%	0%	3%	1%
C17 CL10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0%	1%	0%

ANNEX II, CONTINUED

COMPOSITION OF CHLORINATED PARAFFINS

	UG-MCCP-07	UG-MCCP-09
C14 Cl5	0%	1%
C14 CL6	5%	7%
C14 CL7	8%	17%
C14 CL8	10%	25%
C14 CL9	4%	14%
C14 CL10	1%	3%
C15 CL5	1%	0%
C15 CL6	10%	2%
C15 CL7	19%	7%
C15 CL8	22%	10%
C15 CL9	13%	7%
C15 CL10	4%	2%
C16 CL5	0%	0%
C16 CL6	0%	0%
C16 CL7	1%	1%
C16 CL8	1%	1%
C16 CL9	0%	1%
C16 CL10	0%	0%
C17 CL5	0%	0%
C17 CL6	0%	0%
C17 CL7	0%	1%
C17 CL8	0%	1%
C17 CL9	0%	0%
C17 CL10	0%	0%

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