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REVIEW ARTICLE

Toxic Toys Threaten the Health of the Children: An Appraisal of Potential Literature

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ABSTRACT

Children are considered highly susceptible due to their exposure to the environmental pollutants from the toys, playing dough and paint colors. Despite of graving nature of problem, few studies are conducted on the associated risk factors and environmental pollutants. The current review put an effort on exploration the studies of environmental pollutants in children play products and its related effects on children's health. The methods of pollutant's detection were also discussed. The studies covered showed environmental toxicants including a wide range of heavy metals, volatile organic compounds, nonaromatic hydrocarbons, and Bisphenol A and flame retardants. Few studies has reported Chromium (555±144mg/kg) in Chinese-manufactured play dough, Cadmium (10±1.4 mg/kg) in the toy paints of China, and lead (293.8±184.5 mg/kg) in the toy paint of USA. Therefore, a dire need of research and strong legislation is needed to create awareness to protect the health of children.
Keywords: Exposure, environmental pollutants, health effects, risk factors

INTRODUCTION

Toys are the necessary part of children's life and enhance intellectual power, produce creativity, social interaction and learning. Exposure with toys begin after the birth of a child and continue through the whole childhood period, as the child grows his behavior towards handling of toys also change[1] so toys should be used carefully because they are the important part of children's joy. A recent US hazard analysis shows that Consumer Product Safety Commission reported 1144,240 hospital emergency cases related to toy injuries in 2002. In which mechanical were 92.5%, chemical was 1%, electrical was less than 1% and 6.4% of injuries were undefined. Our concern is about what type of chemical injuries are associated to the children health or from where these chemicals are being transferred to their bodies[2]. Environmental pollutants or toxic materials like heavy metals are used in the manufacturing of the toys, paint colors and play dough. In these toys metal stabilizers are used to stabilize them. These pollutants which are being used as stabilizers have negative impact on the health of the exposed children. Pb, Cd, and As are present in children's products for variety of the reason. For example as stabilizer in many plastics, a paint color enhancer, an anti-corrosion agent in many toys[3]. If one of them is banned second metal is replaced with it and the hazard remains there, such as when restrictions are being imposed on lead, it gets replaced with cadmium. Cd is added in certain plastics to enhance brightness to the color and also protects the toys from HCl production[4]. Other than lead and cadmium the toys also contain other toxic metals like Cu, As, Ni, Sb and these metals are not only present in paint coatings but also in other children's products [5]. Mono aromatic hydrocarbons such as BTEX and styrene also have negative impacts on health; BTEX and styrene are present on the surface of toys found in the chocolate food items[6].

The emissions of these mono aromatic compounds can easily absorb in the food items. Flame retardants, phthalates and Bisphenol A are mainly used in these toys and may pose chronic adverse health effects on children's health. Phthalates are used as plasticizers in many toy's products[7].

Worldwide different countries have different regulations and departments for guidelines on the safety of toys like National institute of metrology in Brazil is made for checking the quality of toys. In United States of America (USA), Environmental Protection Agency (USEPA) is used to design quality standards for toys. European Union, Consumer Product Safety Commission (CPSC) [8] and Directive 2009/48/ are main departments for toys safety[9]. Although any such guidelines are missing in Pakistan.

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Toys often have contaminations like trace metals and these toys sold freely in major markets. These regulatory agencies play important role by preventing the sale of these toys because they are not meeting the standards [9]. In European Union countries many toys that were imported from china shows a high quantity of lead so that these toys are withdrawn from market. In 2007 six million toys were called back in the US because of high concentration of lead (Pb)[10]. In 2010, 12 million McDonald's cups were called back in the US because of high concentration of cadmium (Cd) in the paint coatings[11,12,13].

Exposure of pollutants among children through toys, play dough and other products is increasing because they are available in local market and are accessible to every single being because they are low both in quality and prices. In toy market it is estimated that total 87% toys are imported from which 74% share is of china. These are widely distributed in markets and these toys are not costly because of low cost raw materials and sometimes recycled electronic waste is used in the manufacturing of these toys[14,15].

In Pakistan a research was conducted in 2010 at Karachi University Centralized Science Laboratory, tested the imported toys randomly collected from city markets. This laboratory tested the 14 toys samples in which 8 are soft and 6 are hard toys. The test shows the results that the toxic metals present in both toys manufacturing material and paint coatings. The test also revealed the presence of lead, cadmium and phthalates and all of these exceeding the EU limit standards of 0.1% by mass of plasticized material.

Problem statement: Exposure to environmental pollutants is a serious threat to the children health. The risk of the exposure through toys is increasing because of the mouthing behavior and threat of the ingestion is common among children. Toxic exposures in children are of great concern because of different reasons which includes a high level of metabolism and more ratio of surface area to weight than adults, rapid muscle growth and rapid growth and development issue such as bone and brain[16]. Different studies reviewed that the heavy metal toxicity is one of the major reason for different syndromes and anxiety disorders among children. Exposure to cadmium and lead leads to serious risks to children's health and development of their minds. High concentrations of these metals have been linked to the development of brain neurons and reduced kidney function[17,18].

Other than heavy metals different pollutants like phthalates, bisphenol A and flame retardants are use in toys and pose harmful health effects in children. Phthalates have been reported to disrupt reproductive tract development[7], behavioral problems in children[19] and causes allergic reactions like eczema[20,21]. Although phthalates are administrated in many countries but the presence of these toys based drugs are still a problem[22]. Bisphenol A is reported as an endocrine disruptor of chemicals and young children are significantly vulnerable to them[23,24]. Certain fire resistors have been

linked with a wide range of adverse health effects like thyroid disruption, cancer and sterilization[25]. Flame retardants are likely to leach to saliva due to mouthing behavior of children[26]. This review paper has been prepared to clarify the existing issues related to exposure of a child to harmful and toxic substances in toys. The steps have to be taken to end the situation in current terms and conditions.

Children's Exposure and Regulatory gaps: Exposure to toxic is a major problem for children because children drink more fluids, eat more food and breathe more air per kilogram of body weight. Diseases which appear after long latency periods are more likely to appear in the children[16]. A toy means something different for children of different ages. As a result children of different ages treat toys differently so that their exposure pattern is different. Chewing, chewing and swallowing behavior of children are a common source of exposure to toxic metals, especially during the oral phase that ranges from birth to the age of six[27,28]. This is due to the fact that building materials and paint are easily tied to the outside and can easily ingest into the body.

The US Environmental Protection Agency EPA listed around 80 thousand chemicals in its Toxic Substances Control Act (TSCA) inventory[29]. Under TSCA a great deal of risk and exposure data are required before EPA does something to stop the use of chemicals. Historically, when they interacted during chemical exposures and illness and injury were well documented. EPA has done little curb its use (Chemical regulation Washington, DC, 2005). It is widely known that TSCA is not updated and EPA and advocacy groups are pushing for legislative innovations (EPA US). Other authorities in state are also concerned about the increase in toxic chemicals in the environment (Healthy Homes and Strategic plans, Washington, DC, 2009). With regard to the needs of toys in the USA and other developed countries with a particular focus on mechanical safety such as prevention, chasing, burglary or other injuries. As striking accidents remains the leading cause of toy related injuries. This is an important area of ongoing focus (24th Annual Survey Of toy's safety, Washington, DC, 2009). Until, there has been given a little attention to chemicals in toys. Under current law the CPSC limits the use of 14 chemicals in toys together with 8 heavy metals and 6 phthalates[30].

METHODICAL APPROACH

Search of literature: The articles reviewed to compile the information were obtained by a comprehensive search on scientific issues including safety reports by Science Direct, Pub Med and WHO. The focus was on the peer- reviewed journals and academic reports. The key words used during the study were "Children's exposure", "Lead based paints", "Heavy metals in toys", "PVC toys "Toxic materials in toys", "VOCs" and Mono aromatic hydrocarbons exposed. Boolean operators and truncations were used during the search using key words.

Inclusive studies: The search of literature covered broadly two main issues; the type of materials used in making the children's toy products and methods of risk assessment from having these toys in close proximity of kids.

Exclusive studies: All studies discussing play products made with environment friendly materials were excluded.

Data compilation and presentation

For a comprehensive reading and understanding, the toy products were than categorized as metallic & plastic toys, play dough (clay), crayons & painted toys. The data is presented based on types of toy material and method of risk assessment.

RESULTS AND DISCUSSIONS

This section comprises of results found in all searched studies in broadly two ways, material of toys and methods of risk determination used.

Detection methods for different toys materials: For the detection of VOC from Chocolate/toy sets the method used were Thermal desorption technique (TD) combined with gas chromatography technique (GC) and Flame Ionization detection (FID)[31,32]. For the detection of mono aromatic hydrocarbons (BTEX and Styrene) from the plastic toys Fourier Transform infrared spectroscopy (FTR) was used and for the emissions detection Markes-Micro chamber/Thermal extractor TM (µ-CTETM) was used[33]. For the detection of inorganic constituents from the modeling clay (toy) inductively coupled plasma optical emission spectrometer (ICP-OES) and inductively coupled plasma mass spectrometer ICP-MS were used[34]. For the detection of Phthalates, Bisphenol A and flame retardants from the soft non PVC toys the screening test x-ray florescence (XRF) was used, for BPA High pressure liquid chromatography (HPLC) and Fourier transform Infrared (FTIR) were used, for flame retardants XRF spectrometry was used[35]. For toxic metals from metallic toys ICP-MS was used[5]. For the lead from paint coatings of toys ICP-OES was used (Table 1).

Methods used in different studies worldwide: Methods used worldwide have different pros and cons. Digestion technique used in different studies is important as many instruments like AAS and ICP required the digested form of material or sample. All these methods are designed to check the metal concentration in different materials. Atomic Absorption Spectrum (AAS) users are moving on to the ICP-MS or ICP-OES because it requires high temperature and it provides higher detection sensitivity. However, different other methods are used in different studies to determine other type of materials other than the metals. For instance, for eco-toxicity and TVOCs are determined by the Microtox studies or Xenoscreen methods.

Studies on the material used for children's toys

Plastic and metallic toys: High levels of contaminations present in the range of 3273 to 2280ng/g in plastic toys, which concluded that the high level of concentration of VOC from plastic containers was because of color use (pigment used for coating) and the material type. Emissions from the plastics can easily get absorbed in chocolate food items. Commission Regulation (EU) No 10/2011 of 14 January 2011 is present for plastic materials but no limit values are present. In addition, the document referenced revealed SML number values (mg/kg) only, which is the specified migration limit used for the item. There is a lack of general information about the emission limits of TVOCs that create plastic materials that interact directly with food products. From polymeric toys nonaromatic hydrocarbons (BTEX and styrene) are emitted and also there was no standard for the regulation of mono aromatic hydrocarbons (Table 2).

Playing dough and crayons: The determination of the mineral composition (Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, S, Sb, Se, Sr, V, Zn) from clay were accurate and precise, with reliable results obtained through ICP-based methods. Total of 21 elements were found. Analyses of children's clay samples showed that the concentration of the elements were within the highest limits allowed by INMETRO (As, Ba, Cd, Cr, Pb, Se and Sb), USEPA (Cd and Pb) and International Directive 2009/48/CE the European Union (As, Ba, Cd, Cu, Cr, Mn, Ni, Pb, Se, Sb and Zn), and in accordance with the restrictions required to allow their use by children. Other substances (Al, Ca, Co, Fe, K, Mg, Na, P, S and Sr) were determined and the concentrations were below the maximum values established in law. Among these highest concentration was for P (57.43mg/g) and the lowest concentration was for Sb (<0.020µg/g) (Table 3).

Paints of toys: From the 14 soft non PVC toys such as plastic toys and soft stuff toys the Phthalates, Bisphenol A and fire resistant's were detected. In which toy yellow duck exceeds in BPA and fire resistant's by 5% from EU standards. Toxic metals such as Cd, Cr, Ni, As, Sb and Pb were detected from the 13 metallic, 29 plastic, 3 Paper/Wood toys, 8 brittle toys and 2 paint coatings of toys. Arsenic, Cadmium and Lead were detected from the different toys showing different concentrations. 5% of 96 toys show the higher lead content exceeded from the US regulatory limit of toys

paints of 90 ppm and highest lead was present in brown color that was 47,600 ppm (Table 4).

Health effects reported in children from contaminated toys: Toys contain many toxic substances that cause serious health effects to the children's health. Toxic substances that are mainly present in toys are the heavy metals, phthalates, brominated flame retardants (BFRs), azo dyes and the bisphenol A. One major harmful material that is present in the toys or toy's paint coatings is lead (Pb). It is neurotoxicant and causes harm to the body organs and the functions of the children's bodies. It also causes harms to the developing fetus. It leaches out of the toys when children handle, suck and swallow the toys coatings material. Cadmium (Cd) is present in the paint coatings of the toys and also it can use in the manufacturing of the plastic toys. It is carcinogenic and cause serious health effects to the children's health. It is exposed to the children when they handle or suck the paint coatings of the toys. Other major health issues that are associated with cadmium are bone softening, kidney problems and low brain development[36]. Phthalates are present in the PVC toys and these can leach out of the toys and cause serious health effects. It is reproductive developmental toxicant that damages liver, kidney, heart and lungs. When pregnant mothers are exposed to the phthalates then their children face behavior problems. It also causes allergic reactions and respiratory problems in children[37]. Brominated flame retardants (BFRs) are present in the soft and hard toys that cause serious health effects to the children. Toddlers and children have high exposure than the older children. These materials leach to the saliva due to the mouthing behavior of the children. These are neurodevelopment toxicants and cause liver toxicity and also disrupt thyroid functions. These can also cause cancer and reduced fertility[38]. Azo dyes are the dyes that are used in the leather toys these are the carcinogenic. They can come in contact via dermal, respiratory and intestinal routes. These can also cause bladder cancer because these are very harmful[39]. Bisphenol A is used in the polycarbonate plastic toys. It has estrogenic effects and many neural and reproductive health effects, are happened due to this substance. Pregnant women are more vulnerable because it is very harmful to the developing fetus[40].

Therefore, these studies have reported toxic substances present in toys and their potential risks to the children's health.

CONCLUSION

In the light of above studies, it is concluded that materials such as volatile organic compounds and nonaromatic hydrocarbons have effect on children health. Heavy metals, toxic metals, chemicals like Bisphenol A and Phthalates in different paints samples, children toys and child care products were found hazardous for children health. . ISO 8124 series and EN 71 series are also present internationally on toys safety. Different laws and rules are present but the enforcement of these laws is missing worldwide. A proper legislation related to the limits of these compounds is needed to be enforcing in all countries. The most hazardous compounds should be banned. A very limited research is carried out on such an important subject, it is therefore recommended to conduct more and more research on children' s toys material and their safety so awareness can be in general masses and policy makers.

Conflict of interest: The authors have no conflict of interest to declare and there is no financial interest to report

Table 1: Methods used in different studies worldwide

Region	Materials	Products	Methods used	References
China and Colombia	Lead	Lead based paints in China and Colombo	Digestion, ICP-MS, ICP-OES, AAS (GF AAS), (SS GF AAS)	[10]
USA	Lead, Cadmium, and other heavy metals.	Children toys, toy jewelry, children products (feeding and bathing items, diaper changing mats), soft non PVC toys.	Digestion for sample, ICP-MS, ICP-OES, XRF(mainly trace metals)	[14]
Israel	Phthalates, BPA	Children toys, toy jewelry, other products (feeding and bathing items and other), soft non PVC toys	FTIR Spectroscopy (for screening, HPLC	[9]
Brazil	Different trace metals and inorganic constituents	In the analysis of the playing dough for the children	Digestion, ICP-MS, ICP-OES.	[8]
Poland	Mono aromatic hydrocarbons	In small polymeric toys in chocolate food products	FTIR, DSC and TGA analysis, thermal desorption along with GC and MC	[31]
Poland	Eco toxicity and TVOCs (total volatile organic compounds)	In food and children toy products	Extraction studies, Microtox studies, Xenoscreen studies, FITR technique	[2]

Table 2: Studies reporting plastic and metallic toys

Materials	Detection	Outcomes	References
Plastic capsules inside chocolate to cover toys (both yellow and white) and plastic packing toys	VOCs	Standard values are not present	[2]
Plastic toys	As, Pb, Cd, Cr, Ni and Sb	Not exceeds from standards	[10]
Playing plastic products	As, Cd and Pb	Not exceeds from standards	[24]

*European Union migration limits for toy safety of limit (III)

Table 3: List of studies reporting play-dough and crayons

Materials	Detection	Outcomes	References
Modeling clay	P, Pb, Sb, Ni, Cr, Cd,	Not exceeds from standards	[8]
color play dough	As, Pb, Cd, Cr, Ni and Sb	Only Cr exceeds from standards	[10]
Purple play dough	As, Cd and Pb	Not exceeds from standards	[24]
Oil crayon set	As, Pb, Cd, Cr, Ni, Sb	Not exceeds from standards	[10]

⁎European Union migration limits for toy safety of limit (I).

Table 4: List of studies on of toy' paints

Materials	Detection	Values detected	Standard	References
Brown paint	Lead	47,600ppm	Exceeds	[11]
Orange paint	Lead	14,750ppm	Exceeds	
Yellow paint	Lead	5398ppm	Exceeds	
Green paint	Lead	457ppm	Exceeds	
White paint	Lead	449ppm	Exceeds	
Black paint on toy car	As	ND	3.8 mg/kg	[10]
	Pb	ND	13.5 mg/kg	
	Cd	10±1.4 mg/kg	1.9 mg/kg	
	Cr	8.2 mg/kg	37.5 mg/kg	
	Ni	33±5.2 mg/kg	75 mg/kg	
	Sb	0.61 mg/kg	45 mg/kg	
Blue paint on toy bricks	As	ND	3.8 mg/kg	[10]
	Pb	ND	13.5 mg/kg	
	Cd	ND	1.9 mg/kg	
	Cr	16 mg/kg	37.5 mg/kg	
	Ni	65 mg/kg	75 mg/kg	
	Sb	18±4.9 mg/kg	g/kg	

*European Union migration limits for toy safety of limit (I). *ND stands for not detected.

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