Chapter 7

Discussion and Conclusion
7. Introduction

The present contribution is a modest endeavour to explore the potential risk of toys used by the children. Needless to mention, the history of toys is as old as the history of human civilization. Irrespective of the age range of an individual, the emphasis of recreational activity is greatly centered around toys, and for obvious reasons, the business scenario is constantly undergoing exploration with the variety of toys at unprecedented frequency, volume and intensity. The pretext at which the toy manufacturers are bustling at marketplaces that the toys are essential to the development of physical, psychological, social and the intelligence of children. Like the global toy market, the Indian scenario is also fast emerging and the trend will continue unabated, since India’s demographic pattern is slanted towards growth in the younger population. It is estimated that there are over 130 million children in the age range below six years.

There is no denying that the toys, games and mental development of children are integral, and therefore, from infancy, the parents not only expect different kinds of toys, but also search toys for the requirement that may facilitate intellectual achievement for their dear ones. As on the current context, the Indian volume-driven, price-competitive toy manufacturing industry is still dominates as the unorganized small enterprises, with a vast gap from the organized manufacturing sector. Elsewhere in this contribution, it has been described that nearly 95% of the source marketing of toys is located in the metropolitan
cities of Mumbai and Delhi, and these cities are the central locations from where shipment of toys reaches to all corners of the country, even to remote settlements.

For some time now, public sensitization has been visible around the global that the chemical constituents, both organic and inorganic compounds, used in the manufacturing of toys, carry potential health risk to the children. The focal concern is that the coloured toys made up of PVC and different pigments, when chewed or sucked the children get exposed to heavy metals and plasticizers. Because of the fact that lead and cadmium are readily available and cheapest, these metals are commonly used stabilizer in plastic toys. Arsenic, cadmium, mercury, lead and chromium metals are used in toys for one or other reason. Due to their non-biodegradable nature and long biological half-lives, exposure to toxic heavy metals, even at extremely small concentrations, can cause profound biochemical changes in the body. Many diseases are associated with the elevated heavy metal content in the body; leave aside the definitive level of essential elements, no level of heavy metals in blood is considered safe. Along with exposure to toxic compounds, several factors, such as higher metabolic rate, greater body surface area to body weight ratio than adults, immaturity of organ systems, and tissues contribute in aggravating health risk of the children. The levels of exposure in children differs from that of adults, due to their relative increase in food intake, fluid consumption and increased quantity of breathing volume per reference kilogram of body weight.
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Studies from different countries (refer to Table 1.5) revealed the levels of heavy metals in different kinds of toys. As elucidated in the earlier chapters, there may be many sources of exposures of heavy metals to children, including migration of metals from the toys, which in turn, ascertain the body burden of heavy metals. Apart from the type of toys used, the children’s behaviors of playing with the toys, as well as environmental contamination and household conditions have bearing on migration of toxic metals and materials. With a brief comprehension of the subject, the present research encompassed (a) a questionnaire based enquiring of the types and categories of toys used by the children (N=1063) in the age range of 3-7 years, from urban, semi-urban and rural locale (~36% of the children were below 5 year of age); (b) determining presence of heavy metals (Pb, Cd, Cr, As, Hg) in the new (N=639) and old used toys (N=53; about 1 year old) available from urban and rural areas of western states of India, namely Gujarat, Rajasthan, and Maharashtra, (c) ascertaining the extent of migration of Pb and Cd from the new and used toys, and (d) determining the burden of heavy metals in the children’s blood (N=233). Of the total number of children surveyed, both boys and girls were equal in proportion, and similar in body status (BMI ranged between 13.6 to 14.4 kg/m²).

For the purpose of categorizing the toys, an innovative method was applied based on pre-defined criteria/score (refer to section 2.1.1), and accordingly the branded, unbranded and local toys were grouped. Similar methodology might be useful in large scale survey, covering samples from different countries. This has important bearing in
view of the fact that the Indian marketplace is currently a melting pot of consignments coming from many neighbouring countries, including China.

The characteristic information emerged from the survey about the children’s behaviour in use pattern and style of playing with the toys. In the childhood, playing with different types of toys is one of the methods of socialization. The selection of toys is considered as the characteristics of the experience and ability of the children to develop certain skills. The present study corroborates with other earlier studies. Children have their own choices for category and colour of toys. Every child has their own style of playing, and the kinds of toys stimulate in prolonging play. A child around 3-4 years of age may handle a toy in a different manner from a child around 4–7 years of age. Predominant gender-specific toy preferences have been noted; frequently preferred toys were dolls (~36%), mostly preferred by girls, animals (~21%) and motor vehicles (~35%), mostly favoured by boys. Over 90% of the children were playing with unbranded toys. About 2/5th of the children liked red/pink coloured toys as their favourite ones, and 1/3rd of the children preferred other colours (green, black, white and violet together), with very consistent trend among boys and girls. Some children chew toy, some suck and some throw it. They have habits of eating dust, pencil chewing, nail biting. Sucking is a very common habit among the children (41-43% among girls and boys). About 1/3rd of the children had either a habit to consuming dust/chalk/charcoal or nail biting or thumbs
Chewing habits were similar among boys and girls (~7%). Boys showed more throwing habits, as compared to girl children.

Since a toy constitutes different components, e.g., a baby doll has its body, hair, dress materials and jewelry, the analytical process of determining heavy metals in toys involved several steps, like separating the components of a toy and its accessories, and preparing homogeneous fine powder for digestion and analysis of heavy metals using Atomic Absorption Spectrophotometer. Apart from determining the heavy metals concentrations in different categories of toys, the study covered estimating the extent of migration of metals from new and old used toys, and examining the blood levels of heavy metals in baby boys and girls, and its possible association to the categories, nature and habits of use of toys by the children.

Often priority is given on the concentration of Pb in toys. Analysis shows that Pb levels in toys available from rural and urban areas vary widely. The kind of toy samples collected from the rural areas contained over double the concentration of Pb, as compared to urban toys, the concentrations pooled of rural toys being 19.7±51.9 mg/kg, whereas the levels of pooled urban toys was 9.5±18.8 mg/kg. These variations were significantly noted in the rural unbranded and local toys. Despite wide variations, the urban branded and unbranded toys had very similar levels of Pb. Out of 320 toys procured from rural areas, ~7% of the toys contained Pb concentration as high as 197.7±95.8 mg/kg, and in comparison only 1% of the toy samples from urban areas had Pb concentration exceeded
90 mg/kg (average: 134.1±33.2 mg/kg). The toys from rural Maharashtra showed highest Pb concentration (i.e., 23.0±62.5 mg/kg), in comparison to other states. The urban toys from Rajasthan had relatively higher Pb levels (i.e., 14.6±16.4 mg/kg), as compared to those obtained from urban Gujarat (10.2±15.7 mg/kg) and urban Maharashtra (8.8±20.0 mg/kg). Analysis of fifty three used old toys (~1 year old) taken directly from the urban and semi-urban households revealed that the average concentration of Pb in these toys was 14.4±22.7 mg/kg, with the highest recorded level as 88 mg/kg.

Similar to Pb levels, Cd concentrations in rural local toys contained over double the concentration in rural and urban unbranded toys. The rural local toys contained Cd levels as high as 13.9 mg/kg with over 3.5 times larger standard deviation (47.1 mg/kg). Specific details of the difference in the levels of heavy metals in the rural and urban toys are described in Chapter 4. Twenty toys samples (19 of them were dolls) had Cd levels exceeding 75 mg/kg, and the majority of the toys were multicolored. The toys from rural Maharashtra showed highest Cd concentration (i.e., 18.7±51.0 mg/kg), in comparison to other states. Used old toys, however, contained much lower level of Cd (e.g., 1.6±2.0 mg/kg). The trend of analysis of Pb and Cd concentration in the new toys is a clear indication that the shipments of toys to the rural regions are the different lots. The implication is obvious that the children in the rural areas are potentially at higher risk of toxicity through the types of toys used. The situations are no different for other metals examined in the study. Cr concentrations in rural toys contained about 1.5 times the level,
as compared to urban toys (p<0.05), the pooled value being 5.5 ± 13.0 mg/kg. Rural local toys had the highest Cr values (8.7±20.9 mg/kg), as compared to branded and unbranded category of toys. Toys from rural Rajasthan showed highest Cr concentration (i.e., 7.8±6.9 mg/kg). About 2% of the toys contained Cr level exceeding the permissible level of 60 mg/kg (ranging from 91.5 to 144.7 mg/kg), and all these samples were local toys, and only one belonged to urban branded category. Used old toys also showed some quantity of Cr and the relative level is about 1/3rd to those of the new toys. Information as regard to conversion from Cr$^{+3}$ to Cr$^{+6}$ from the toys in the salivary and gastric media are yet to be explored.

Mercury levels in toys of rural and urban areas were much below the BIS level of 60 mg/kg. The urban toys from the state of Gujarat showed highest Hg concentration (i.e., 0.24 ±0.14 mg/kg), i.e., even the highest concentration of Hg found in toys is a meagre level, as compared to the BIS recommended standard. The researcher has a view that the permissible standard proposed for Hg may be reviewed, since even a minute quantity of Hg in inorganic and organic form carry high health risk, and should not be ignored.

Rural toys, contained marginally higher As concentration (0.33±1.17 mg/kg), as compared to urban toys (0.27±0.72 mg/kg). Rural toys of Gujarat and Rajasthan contained relatively higher As concentration, exception being the toys from Maharashtra regions, where the urban toys had higher As level than the rural toys. Nevertheless arsenic levels in most toys were within the permissible limit, even the trace level of As concentration in the
human system may be of serious concern. Reference to Table 4.18, 5% unbranded multi-coloured animated toy samples had As concentration with average level greater than 2 mg/kg, highest being 16.43 mg/kg. Incidentally, all these unbranded animated toys were from Maharashtra. It is worthy to note that the average As levels in used old toys (0.49±1.06 mg/kg) were nearly double to that concentrations in the new toys, with a large inter-individual variations in the samples.

The migration of Pb and Cd were examined in artificial gastric media, covering 22 new toy samples that had Pb concentration more than 90 ppm, 19 new toys, in which Cd concentration exceeded 75 ppm and 53 old used toys. Analysis revealed (Table 5.1) that the used old toys have completely different behaviour of migration, in contrast to the new toys. The average migrated Pb and Cd concentrations from old used toys were about 5 and 3% of the initial concentrations, respectively. In contrast, the migrated Pb and Cd quantities in new toy samples were about 0.23% and 0.02% of the total Pb concentration. Comparatively increased migration of metals implies substantial leaching of heavy metals from the used old toys, suggesting that the surface coating/paints of the used old toys might be more exposed and brittle. The minute brittle particles can probably get easily absorbed in the body system. All concerned may take cognizance of the fact that acid extraction test for migration study was carried out for a duration of 2 hours, as per the defined procedure; on the other hand, sucking, chewing, swallowing of toys by the children continues for days and months together, and therefore, accumulation of the heavy
metals continues in the system, and the cumulative body burden cannot be discounted. Therefore, a caution has been raised that the parents might discourage children to play with very old toys, since migration of heavy metals may be very high, with likely increased accumulation in the body system of the children.

Chapter 6 brings in analysis of the burden of heavy metals with reference to its levels in blood in children who were using different kind toys in the recent past. Due to a variety of behavioural pattern of the children in playing with their toys, toxic metals leach out to the body system. Mouthing behavior includes all activities in which objects, including fingers, are touched by the mouth or put into the mouth—except for eating and drinking, including licking, sucking, chewing, and biting of toys.

The basic premise is that accumulation of heavy metals even at trace levels may cause serious health problem in children, with relative susceptibility. The heavy metals included in the present analysis, e.g., Pb, Cd, Hg and As are non-essential metals and it is toxic even at a trace level, whereas, Cr is an essential metal but excess of it is hazardous. It was observed in this study that there are consistent trend of different metals, with respect to ways of playing with the toys by the children. The heavy metal concentrations in blood were relatively higher in boys, as compared to levels in girls, excepting that blood chromium levels were higher among girls. Pb and As levels in blood were higher in boys of ≥5 years, whereas Cd, Hg and Cr levels in blood were higher in boys below 5 years of age. While only 1% of the total number of children had BLLs exceeding <10 µg/dl, as
many as 15% of the children had BLL above 5 µg/dl. About 5% of the total number of children had blood Cd levels more than the recommended limits (0.5 µg/dl); As many as 12% of the children below 5 years of age exceeded the recommended limits. Nearly 10% of the children had blood Cr levels above the recommended toxic level (3.0 µg/dl) and 3% of the children exceeded the recommended limits of blood mercury and arsenic.

Extensive analysis of the content of heavy metals in new and used toys and the presence of the heavy metals in the blood in different concentrations are suggestive that the majority of the children did not reach to the toxic level of their exposure. However, it is recognized that the exposures were cumulative with the presence of multiple metals. This thesis was not within the scope to explore the consequent effects of longitudinal exposure to multiple metals in the children. Due to the fact that the children’s choices of toys vary with the type and colour, the longitudinal investigation might elucidate the relative load from different types and categories of toys.

The findings of the present thesis are indicative that there are multiplicity of influencing factors, such as children’s behavior of playing with the toys, cumulative heavy metal concentration in the new and old toys, as well as the migration and building up the body load of the toxic metals. Recognizing that the accumulation of heavy metals in the body might also be influenced by other biological characteristics of the children, for regulatory reasons, it is imperative for all nations to periodically review the permissible standards of chemical constituents, including migration and body loading by the heavy
metals, which might be considered safe. Different the Safety regulatory guidelines have been proposed by international and national standards bodies. Bureau of Indian standards have also adopted the ISO standard 8124-3, recommending maximum acceptable element migration limits from toy materials as 90, 75, 60, 60 and 25 mg/kg for Pb, Cd, Cr, Hg and As respectively. There is presence of other metals in the toys in different concentrations. Standardized constituents in the making of toys are the collective responsibility of the manufacturers globally. Since all ISO and national standards are reviewed every five years, the ISO 8124-3 (1997) will perhaps undergo scrutiny and review soon.

The manufacturers are in constant search to modify the chemical constituents of the toys. It is important for parental education along with manufacturers’ strict guidelines on package warnings, labelling of chemical constituents in the toys, etc. People must be aware that no level of Pb, Cd or Hg in blood shall be considered as safe for children, and every effort should be made to ensure that the relative body burden of chemicals should be such that they are free of any threat to toxics metals. Children and pregnant mothers are especially vulnerable to Pb poisoning. It also affects the cognitive function of brain. Long use of a toy may be discouraged to mitigate health risk to the children, since the used olds toys may have significantly higher level of Pb as compared to new toys.