Toxic Trinkets

An Investigation of Lead in Children's Jewellery in India

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Toxics Link

INDIA

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Foreword

Lead is a toxic heavy metal, and has a major impact on health, especially on children's health. Though its toxicity has been recognized as early as the 1900s, it is still found in everyday products. Paints, jewellery, cosmetics, toys, pipes, and even gasoline have lead in it. In many countries, owing to a recognition of lead's ability to lower IQ across populations, its capacity to impact brain functions, and also to enter the baby's food through breast milk, or by crossing the placental barrier, added lead is no longer permitted to be intentionally used.

The limits on lead permissible, even as background levels, have been decreasing constantly. Today, as the WHO is reviewing the current science on it, it is widely being accepted that there is 'no safe level', and that impacts on health can occur even at very low levels of lead in the blood.

It is then surprising that across the developing world, lead is still widely used in products. Toxics Link's earlier investigations into toys, and paints, not only in India but also across several countries revealed the dismal situation. It is even more damning to learn that companies which manufacture such products, do not use lead in markets which do not allow it, such as Europe and the US, but use it in India, Africa or South East Asia. Cleary there is a case for corporate double standards, and intentional poisoning of the most vulnerable and poorest populations of the world. This is especially disturbing since equivalent and price comparable substitutes are readily available and have been so for over fifty years.

This investigation of lead in children's jewellery is to determine its use in this product. The findings are startling, since the high levels suggest that lead comes here through pigments and paints. Also there have been several export consignments of such trinkets, which have been sent back from countries like the US for this reason.

Lead must not be added to products. Also, it is imperative that India mandate strict standards for lead and other heavy metals in products, especially paints, which seems to be a root cause. This is critical not only from market perspectives but more importantly to protect our next generation.

Ravi Agarwal
Director

About Toxics Link

Toxics Link is an information outreach and environmental advocacy organization set up in 1996. It has special emphasis on reaching out to grassroots groups and community based organizations. The areas of its engagements include research, outreach and policy advocacy on issues of communities and urban waste, toxics free healthcare, hazardous wastes and pesticides.

Toxics Link communicates with all stakeholders, from a civil society perspective. Its networks and partners are national, regional as well as international.

Investigation Team

Prashant Rajankar and Ragini Kumar

Mission of the organization

"*Working together for environmental justice and freedom from toxics.*"

"We have taken upon ourselves to collect and share both information about the sources and dangers of poisons in our environment and bodies, and information about clean and sustainable alternatives for India and rest of the world"

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Prashant Rajankar and Ragini Kumar

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Executive summary

Jewellery, an item of adornment is popular among different cross sections of Indian society. Its prevalence in the Indian society since time immemorial depicts the high demand for the products, which in present times are not only sold but also manufactured in many parts of the country. A number of Indian states are manufacturing traditional, ethnic, contemporary, and tribal jewelleries. These jewellery pieces are often hand crafted and also mass-produced. Some of the important states being Assam, Delhi, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and West Bengal. The high popularity of the product also signifies the export and import of these items.

In the present era of consumerism, children cannot be isolated from this humungous demand. Children use many kinds of jewelleries like bracelets, pendants, rings etc. Of late, a major rise in demand is seen in artificial jewellery of which the most popular among kids is the costume jewellery, which can be mixed and matched with the dresses. To attract children even more, the manufacturers of these jewellery items coat them with bright colours. This coating can prove to be a problem as, most of these colours are organo-metallic compounds, which are loosely bound to the surface and can leach easily.

Juxtaposed with the market trend is the general tendency among children (especially toddlers) to chew or suck jewellery items they wear (mostly at the time of teething). It is therefore necessary to ensure that these jewellery items do not have any toxic elements in them.

In our effort to bring toxic substances and chemicals, their use in everyday products and impact on human health and environment in the public domain, we bring a study on lead in jewellery, this time examining imitation jewellery used by children. The present study reveals that this artificial children's jewellery can have impacts on health as it contains considerable amount of lead. It has also been established medically worldwide, that lead is a potent neurotoxin causing irreversible harms to human health and environment.

The United States' Agency for Toxic Substances and Disease Registry (ATSDR), 2005 summarizes the health impacts of lead stating, "The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults to lead at work has resulted in decreased performance in some tests that measure functions of the nervous system. Lead exposure may also cause weakness in fingers, wrists or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people. Lead exposure may also cause anemia. At high levels of exposure, lead can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production." The United States Consumer Products Safety Improvement Act 2008 brought a standard for lead in children's products, ascertaining it to a maximum allowable limit of 300 parts per million. However, no such standards exist in India.

The Study

The aim of the report is to examine the usage of lead in products especially those used by children and youth, as well as to survey the size of the market for artificial jewellery in India.

54 samples were collected from various manufacturing and retailing markets across Delhi to examine lead concentration in different children's jewellery pieces (necklace, ring, bangle, bracelet, earrings and hoops), which give an insight into the presence of the contaminant in most products. A few samples from roadside vendors were also collected for the study.

All children's jewellery samples were collected from different markets viz., Central Delhi, Janpath, South, Lajpat Nagar, Old Delhi, and Sadar Bazaar. A total of 54 samples were collected.

Results

Among total 54 children's jewellery samples collected, 64.8 percent samples (35 out of 54) were found to contain lead more than 90 ppm, 44.4 percent samples (24 out of 54) contain lead more than 300 ppm, and 38.9 percent samples (21 out of 54) contain lead level more than 600 ppm. Among the total number of samples, lead level varied from the lowest 12.68 to as high as 343415.64 ppm. The lowest lead level (12.68 ppm) was found in a bracelet-twisted oxidized sample while the highest lead level was found in a multi coloured charm bracelet sample.

Plate 1 Jewelleries in India

Key findings

1. All 54 children's jewellery samples contain lead in varied range.
2. Among the total number of samples tested, ring samples contain the highest amount of lead, i.e. 856346.9 ppm.
3. Ring samples; despite being small in size contain high level of lead, which indicates that lead is used as a malleable material and for giving better shape to the jewellery items.
4. Across all 54 samples, lead concentration is found higher in samples that have decorative colours on it, especially multi-colour
5. Pink is the most common colour found in all sample groups and such samples suggest high lead levels.
6. Not only coloured jewellery samples show high lead level but also non-coated colourless jewellery samples show high content of lead, which clearly indicates that the jewellery item itself contains lead.

The findings are a clear indication of the intensity of the problem and the dangers lead can cause with its presence in children's jewellery.

1. Introduction and Literature Survey

Naturally occurring lead and heavy metals from the earth's curst are widely used in products and processes. Some of these products are used in our everyday lives. At the same time human exposure to lead, causes serious permanent health impacts such as a reduction in IQ levels, kidney damage and even death from lead poisoning. This is well established medically and is substantiated by the WHO, which rates lead as a key toxic metal. Hence, its presence in products may prove fatal.

Many studies in the past have revealed that myriad household products available in the market contain high amounts of lead. These include: paints, toys, ceramics, ayurvedic medicines, jewellery etc. Due to the omnipresence of the contaminant (in household dust, paint, toys etc), children are particularly at a high risk since they are in their formative years.

1.1 Lead in Paints

Paints, depending upon the nature of their usage, can be categorized as decorative or industrial. Decorative paints are primarily used on the interior or exterior of homes and buildings and include other coatings such as emulsions, enamels, varnishes, wood finishes and distempers. A number of lead compounds can be used as pigments in paints such as lead oxide, lead carbonate (also known as white lead) and lead chromates/ molybdates. Although children are known to eat paint chips, more commonly lead paints in and around homes contribute to dust and soil contamination that is often the most significant source of exposure for children. *A Brush With Toxics: An Investigation on Lead in Household Paints in India, 2009*, a study by Toxics Link revealed the metal's presence in household paints in developing countries like India. Another study by Toxics Link, depicts that the dust present in houses also contain lead, which can easily be inhaled or ingested by children through hand or mouth contact. [1]

1.2 Lead in Toys

Any amount of Lead and Cadmium can cause harm to pregnant women or children. The study, *Toying with toxics: An investigation of lead and cadmium in soft toys in three cities of India* [2] revealed that soft toys made of plastics (both PVC and non PVC), contain lead and cadmium.

1.3 Impact of Lead in Children's Jewellery

Children's jewellery has been defined as a "jewellery item(s) which is (are) designed, sized, decorated, packaged, and/or otherwise produced, advertised or sold in such a manner as to make it reasonably apparent that the item(s) is intended to attract, appeal to, or be worn primarily by a child under the age of 15 years."

Children use many kinds of jewellery products like bracelets, pendants, necklaces etc and have a tendency to put such items into their mouth and even suck or chew them. It therefore needs to be ensured that these jewellery items are safe and do not contain any kind of toxic elements. Yet, children's jewellery has been found to contain lead, making children most susceptible to lead exposures. In the production of art/children's jewellery, some manufacturers use lead as a base metal, often combined with tin, since it produces an alloy that is easy to work with as well as easy for shaping. Besides making it look heavy it is also cheap. In the process of manufacturing, lead gets coated on the jewellery.

Even short-term exposure to lead may cause long-term adversarial impact on children's health. Adding to the grave situation, manufacturers coat jewellery items with bright colours to attract children, while most of these colours have organo-metallic compounds and metals in them, loosely bound to the surface, which can leach easily.

1.4 Jewellery in India: A Historical Perspective

Jewellery is an item of personal adornment, which may be made from gemstones or precious metals like gold, silver etc, further shaped into necklaces, rings, brooch or bracelets, earrings and other body rings. [3]

The history of jewellery is a long one, with different uses among different cultures. The Indian subcontinent has a long and continuous legacy of jewellery making, which has existed since the time of the epics like the Ramayana and the Mahabharata. [4] Initially jewellery was prepared from natural materials, such as bone, animal teeth, shell, wood and carved stone, etc. Later, gemstones and precious metals, such as silver or gold, as well as metals were used.

1.5 Global Experiences of Lead in Children's Jewellery

The jewellery is most often worn by the young, most of them children in the age group between 3-16 years, who are very sensitive to lead exposures, since it is a critical time for neurological development. [5]

The U.S Consumer Product Safety Commission (CPSC) has been consistently recalling consignments of children's jewellery products on account of high lead levels in them. An investigation made by the Baltimore City Health Department, 2004, estimated very high lead levels in children's jewellery sold and marketed for young girls. [6] The investigation also found ring with as high as 6.8 percent in lead by weight, which is more than 100 times the standard for lead internationally. Dr Joshua Sharfstein, Commissioner Health Department, Baltimore commented that the rings, "if ingested accidentally, could cause lead poisoning and seriously threaten the health of a child." [7]

There have also been numerous instances of lead contamination in children's jewellery in developed nations like United States and Canada. A recall of about 2.8 million lead-containing metal charms was carried out in the United States and Canada in March 2005, after a child who had mouthed the charms was found to have high level of lead in her blood.

In 2006, the company Reebok recalled bracelets after a young girl in U.S. died of lead poisoning. [8]

In 2007, the Consumer Product Safety Commission (CPSC) recalled 5,600,300 units produced in China in the first seven months alone. CPSC said that 20,000 children were treated in emergency rooms from 2000 to 2005 after swallowing jewellery. [9] The number doesn't include choking incidents. A 4-year-old boy died in 2007 after swallowing a charm that was 99 percent lead.[10] Ward B. Stone, a wildlife pathologist in New York, observed another alarming finding (2007), when he tested children's metal jewellery (necklaces, bracelets, earrings and toe rings) bought from several *dollar stores* around, none of which carried a warning label that lead was present in the jewellery. He observed that, the samples contained at least 380,000 parts per million or higher amount of lead– over 600 times the then established limit of 600 parts per million, according to Consumer Product Safety Commission (CPSC). Similar test found alarmingly high levels of lead in children's jewellery sold at various Rochester retailers in 2005. [11]

Lead issues are not new in India. The issue of lead in children's jewellery has been brought to the fore through the report purposefully as a first report on the subject.

In India, children's jewellery is manufactured across many cities and towns largely in the small-scale sector. There are currently no norms or standards for these manufacturing processes or end product. There is a high demand for these products across various sections of youth.

1.6 How to Recognize Lead in Jewellery

Lead in jewellery and other products may look different from pure lead, depending on how much lead is in the product. Items that are made with a high percentage of lead are greyish in colour, heavy for their size and may leave a grey mark when rubbed against a piece of white paper if the lead is not coated.

1.7 Market Size of Costume Jewellery Industry In India

Costume jewellery (also called fashion jewellery, junk jewellery, fake jewellery) is jewellery manufactured as ornamentation o**ften** to complement a particular fashionable costume or garment. It is intended to be fashionable for a short period of time and is repurchased to fit with a new outfit or new fashion style. Its main use is in young trendy fashion, as opposed to "real" (fine) jewellery that may be regarded primarily as collectibles, keepsakes, or investments.

Costume jewellery is made of less valuable materials including base metals, glass, plastics, and synthetic stones, in place of more valuable materials such as precious metals and gems. The costume jewellery industry market is currently booming in India giving greater opportunities to children and teenagers to mix and match them with dresses.

India is a significant producer and exporter of costume jewellery to different countries. It contributes nearly 9 percent to the world sales. Also various materials including wood, metals, terracota, leather, bone etc are being used to manufacture and design superior quality and finer finished jewellery pieces.

Cheap availability of labour, easy availability of base metals, faux gems and stones, skilled artisans, and good infrastructure has made India one of the major costume jewellery manufacturers.

1.8 Major Costume Jewellery Manufacturing States

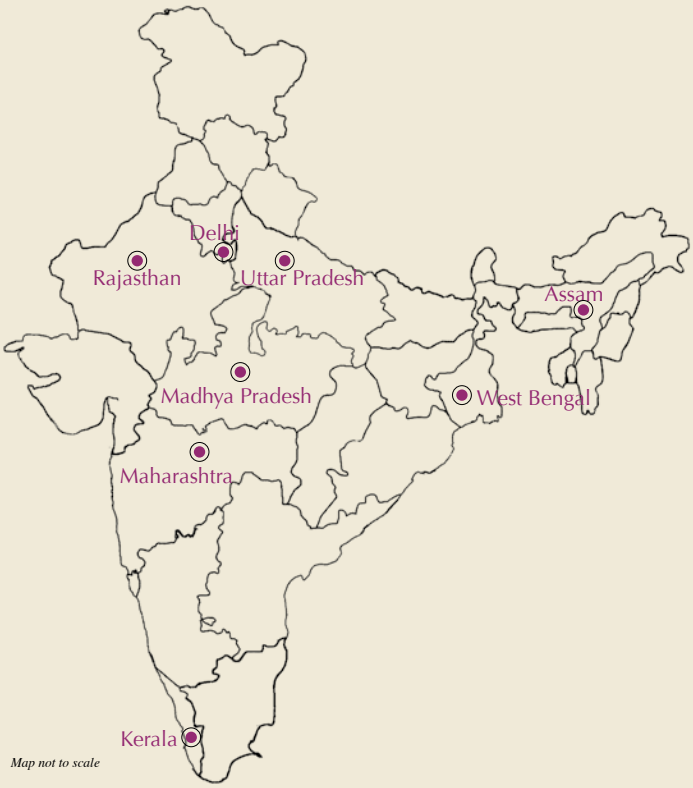

Plate 2- Delhi markets flooded with artificial jewellery for children and adults

A number of Indian states are manufacturing traditional, ethnic, contemporary and tribal jewellery. These jewellery pieces are often hand crafted and also mass-produced.[12] Some of the important states are: ◉ Assam ◉ Delhi ◉ Kerala ◉ Madhya Pradesh ◉ Maharashtra ◉ Rajasthan ◉ Uttar Pradesh and ◉ West Bengal

The state of Rajasthan is popular for its semi precious and stone studded jewellery. Muzaffarpur in the state of Bihar is known for its *lac* jewellery. Moradabad is known for manufacturing high quality and superior finish brass ornaments.

Sadar Bazaar is the biggest wholesale market in Delhi, which sells a variety of household products including imitation jewellery. Most of the shop owners from where samples were collected mainly source their products from this market as well as from other parts of the country. Some of the larger sellers import jewellery from countries like China.

1.9 Major Export Markets

India exports high quality jewellery pieces in different designs to a number of countries.[12] Some of the major export destinations are:

- EU
- USA
- New Zealand
- Middle eastern countries

1.10 Health Hazards

1.10.1 Toxicity of Lead

It has been well established that lead is toxic. [13-14] It is the toxicity of lead that led US Centers for Disease Control and Prevention [15-16] (CDC, 1991) to consider lead concentrations in blood higher or equal to 10 µg/dl as elevated. In fact, a recent body of literature points out that there may be no safety margin at existing exposures and that children exposed to even < 10 µg/dl have also shown intellectual impairment. [17-18-19-20] Some recent investigations have revealed that even low-level and long-term lead exposure can lead to health related problems such as renal dysfunction or delayed puberty in girls. [21-22-23]

Children (below 6 years) are recognized as the most susceptible to lead exposure even at low levels. Pregnant women are the second most vulnerable group. Lead also crosses the placenta and reaches the developing fetus. Absorbed lead is rapidly taken up by blood and soft tissue, followed by a slower redistribution to bone. Bone accumulates lead during much of the human life span and may serve as an endogenous source of lead that may be released slowly over many years after the exposure stops.[24] Symptoms associated with different possible blood lead levels in children and adults are described in figure.[25]

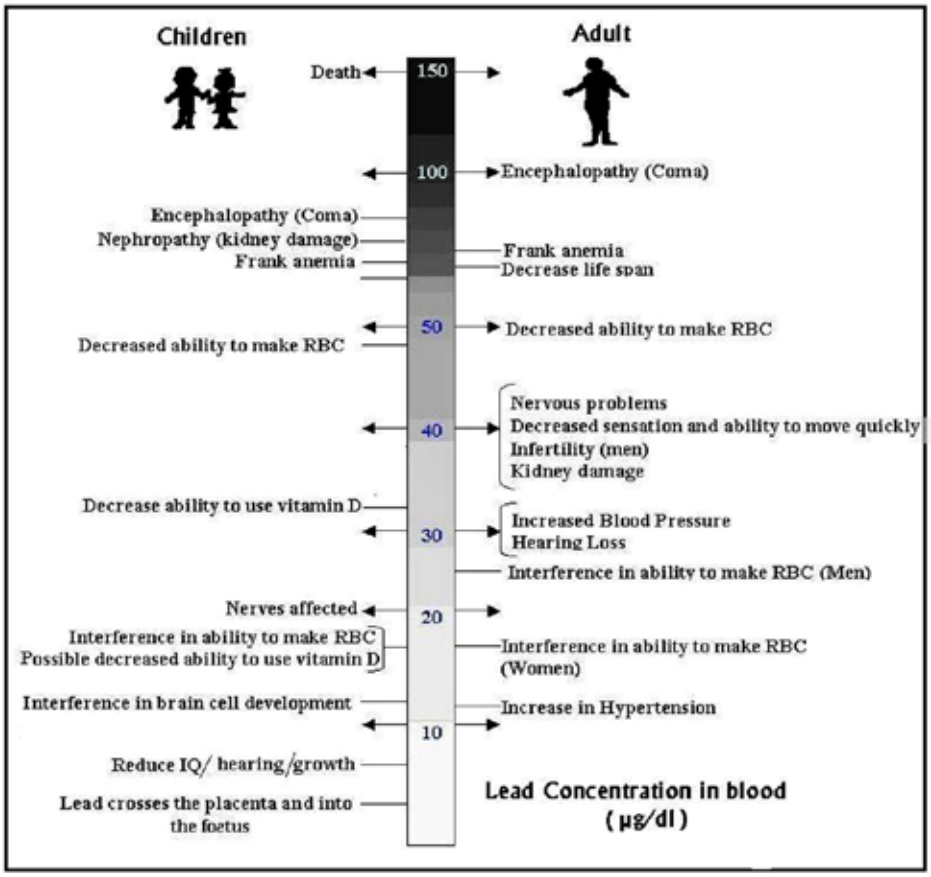

Figure 1.1. Symptoms associated with blood lead levels in children and adults

1.10.2 Exposure Pathways

Human exposure to lead occurs through a combination of inhalation and oral routes, while dermal absorption of inorganic lead compounds is reported to be much less significant than absorption by inhalation or oral routes. Since the markets contain huge quantities of jewellery items that contain lead, inhalation acts as the main reason for contamination for these occupational exposed groups, while contamination through oral route is the root cause for lead contamination among general population. In any case, the effects of lead are same, regardless of the route of exposure (inhalation or oral) and are correlated with internal exposure, as blood lead levels. Even low levels of exposure to lead can result in IQ deficits, learning disabilities, and behavioural problems, stunted or slowed growth, and impaired hearing. At increasingly high levels of exposure, a child may suffer kidney damage; become mentally retarded, fall into a coma, and even die from lead poisoning. Lead poisoning has been associated with a significantly increased high-school dropout rate, as well as increases in juvenile delinquency and criminal behaviour. [26]

Wearing jewellery-containing lead may not cause harm, but children sucking, chewing or swallowing this type of jewellery can cause damage to their bodies, especially to their nervous system. While some jewelleries may have paint or a coating, but this does not make the jewellery safer for children because the coating is temporary and can be chewed or worn off. Children then ingest lead from chewing the jewellery. [27]

Plate 3: Bangle samples

1.10.3 Acute (Short-Term) Health Effects

Death from lead poisoning is likely to occur in children who have blood lead levels greater than 125 µg/dL and brain and kidney damage have been reported at blood lead levels of approximately 100 µg/dL in adults and 80 µg/dL in children. Gastrointestinal symptoms, such as colic, have also been noted in acute exposures at blood lead levels of approximately 60 µg/dL in adults and children. Short-term (acute) animal tests in rats have shown lead to have moderate to high acute toxicity. Effects on glomerular filtration, neurodevelopment, and blood pressure are evident as blood lead levels below 10 µg/dL. The most sensitive targets for the toxic effects of lead are kidneys and the hematological, cardiovascular, and nervous systems. Due to the multi-modes of action of lead in biological systems, lead could potentially affect any system or organ in the body. [28]

1.10.4 Chronic (Long-Term) Health Effects

1.10.4a Non-cancer Risk

Chronic exposure to lead in humans can affect the blood. Anemia has been reported in adults at blood lead levels of 50 to 80 µg/dL, and in children at blood leads levels of 40 to 70 µg/dL. Lead also affects the nervous system. Neurological symptoms have been reported in workers with blood lead levels of 40 to 60 µg/dL, and slowed nerve conduction in peripheral nerves in adults occurs at blood lead levels of 30 to 40 µg/dL. Children

are particularly sensitive to the neurotoxic effects of lead. There is evidence that blood lead levels of 10 to 30 µg/dL, or lower, may affect the hearing threshold and growth and development in children. [28] Meta-analyses conducted on cross-sectional and prospective studies suggest that IQ decline of 1 – 5 points is associated with an increase in lead blood level of 10 µg/dL. No safe threshold for the effects of lead on IQ has been identified.

Other effects from chronic lead exposure in humans include effects on blood pressure and kidney function, and interference with vitamin D metabolism. Animal studies have reported effects similar to those found in humans, with effects on the blood, kidneys and nervous system, immune, and cardiovascular systems. The U.S. Environmental Protection Agency (EPA) has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for elemental lead or inorganic lead compounds. EPA has established a Reference Dose for tetraethyl lead (an organometallic form of lead) of 1 x 10^{7} milligrams per kilogram body weight per day (ppm/d) based on effects in the liver and thymus of rats.

1.10.4b Cancer Risk

Human studies are inconclusive regarding lead exposure and an increased cancer risk. Four major human studies of workers exposed to lead have been carried out; of which, two studies did not find an association between lead exposure and cancer, one study found an increased incidence of respiratory tract and kidney cancers, and the fourth study found excesses for lung and stomach cancers. However, all these studies are limited in usefulness because the route(s) of exposure and levels of lead to which the workers were exposed were not reported. In addition, exposure to other chemicals probably occurred. Animal studies have reported kidney tumors in rats and mice exposed to lead via the oral route. EPA considers lead to be a Group B2— a probable human carcinogen. International Agency for Research on Cancer considers inorganic lead compounds to be probably carcinogenic to humans (Group 2A), and organic lead compounds to be not classifiable as to their carcinogenicity to humans (Group 3). [29]

1.10.5 Reproductive/Developmental Effects

Studies on male lead workers have reported severe depression of sperm count and decreased function of the prostate and/or seminal vesicles at blood lead levels of 40 to 50 µg/dL. These effects may be seen from acute as well as chronic exposures. Occupational exposure to high levels of lead has been associated with a high likelihood of spontaneous abortion in pregnant women. However, the lowest blood lead levels at which this occurs has not been established. These effects may also be seen from acute as well as chronic exposures. Exposure to lead during pregnancy produces toxic effects on the human fetus, including increased risk of preterm delivery, low birth weight, and impaired mental development. These effects have been noted at maternal blood lead levels of 10 to 15 µg/dL, and possibly lower. Decreased IQ scores have been noted in children at blood lead levels of approximately 10 to 50 µg/dL.[28] Human studies are inconclusive regarding the association between lead exposure and other birth defects, while animal studies have shown a relationship between high lead exposure and birth defects.

1.10.6 Exposures in India

A study done by the George Foundation (1999), on lead poisoning in major Indian cities, reported 51.4 percent of the total sampled population having more than 10 µg/dl of Pb-B, while 12.6 percent having more

than 20 µg/dl of Pb-B. In cities like Delhi and Kolkata almost 19 percent of sampled population had blood lead concentration more than 20µg/dl. In Mumbai, 14.7 percent of children had more than 20 µg/dl of blood lead concentration. [30]

In another study done by Kalra, *et al*., in 2003, it was found that the mean Pb-B was 7.8 µg/dl and proportion of children having more than 10 µg/dl of Pb-B was 18.4 percent. [31] It also suggested that distance of the residence or school from a main road appeared to be associated with higher blood lead concentrations, but these differences were not statistically significant. Similar reports depict high concentrations of blood lead in children in various other cities in India and relate it with local practices and exposure pathways. [32-33]

1.11 Environmental Hazards

Lead is extremely persistent in both water and soil. The presence of lead varies widely depending on such factors as temperature, pH, and the presence of humic materials. Although combustion of leaded gasoline was one of the primary sources of anthropogenic atmospheric releases of lead, industrial releases from smelters, battery plants, chemical plants, and disturbance of older structures containing lead based paints are now major contributors to total lead releases. Biologists have studied the effects of lead sinkers and jigs on water birds, such as loons and swans, since the 1970s. A single fishing sinker swallowed with food or taken up as grit could be fatal to water birds. Lead adversely affects the function and structure of the kidney, central nervous system, bones, and production and development of blood cells in water birds. Exposure to lead, such as through ingestion of fishing sinkers, can cause lead poisoning in waterbirds, producing convulsions, coma, and death [34]

1. 12 Regulations for Lead in Children's Jewellery

Table 1.1: Standard Regulations for Lead

Country	Allowable lead in Paint	Allowable lead in Children's products
USA	90 ppm	300 ppm for lead in children's product [35]
Canada	90 ppm	600 ppm total lead and 90 ppm migratable lead [36]
European Union	No Added lead	100 ppm
India (voluntary standard for lead in paint) [37]	1000 ppm	No specific regulation for lead in children's jewellery

1.13 Intent of the Regulation

In keeping with the harmful effects of lead on children, the intent of the regulation is to remove lead containing jewellery from marketplace, which is designed for young children. A large portion of costume jewellery sold contains lead. There is no lead exposure risk associated with wearing lead-containing jewellery, but lead exposure can occur when the jewellery is chewed or sucked. Lead components of costume jewellery are often covered with a protective or decorative coating, but such coatings may be readily removed when the item is sucked or chewed. Young children have a natural habit of putting items into their mouths and lead has a sweetish taste, which encourages children to chew or suck lead-containing jewellery even more.

2. Study Objectives and Methodology

2.1 Objectives

To study the levels of lead in children's jewellery

To understand the situation in the country and internationally

2.2 Sampling and Methodology

2.2.1 Sampling

The scope of jewellery market is very large in Delhi. Costume jewellery is readily available in nearly all parts of the city. Children's jewellery can be found from roadside vendors to big shops and shopping malls.

For the present study, the samples were collected from three different markets from three geographical locations: Central, South and old Delhi, namely; Janpath, Lajpat Nagar, Old Delhi market, and Sadar Bazaar. A total of 54 samples were collected to examine lead concentration in different jewellery pieces (necklace, ring, bangle, bracelet, earrings and hoops). A few samples from roadside vendors were also collected for the study. Annexure I

Plate 4-Kinds of earring and ring samples Collected

Samples were collected and analyzed as per Standard Operating Procedures for Lead in Jewellery by Hotplate or Microwave-based Acid Digestions and Inductively Coupled Plasma Emission Spectroscopy, EPA, PB92-114172, Sept. 1991; SW846-740. [38] Delhi Test House made an analysis of the samples collected with the help of a laboratory study.

2.2.2 Articles

Individual sub-sample within the total number of samples, such as a necklace, a ring or a bracelet were subjected to lead testing. Ideally, the sample should contain only identical items, not a mix of several different items. An item such as a bracelet may be broken into its component parts such as bead, hook, or a pendant, with those component parts individually analyzed.

2.3 Standard Operating Procedure for determination of Lead in Children's Metal Jewellery

Scope of the method - This method describes the determination of lead in Children's Metal Jewellery and may also be applicable to the determination of other elements.

Graphite Furnace Atomic Absorption Spectrometer (GF-AAS) determines Principle of the method- the sample is digested in closed digestion assembly in presence of Oxy acid (Suprapur Grade Nitric Acid) and Hydrogen Peroxide and after making a fixed volume, lead content.

Chemical and Glassware used

- 1000 mg/l Lead Standard Solution traceable to SRM (MERCK)
- Nitric Acid (Lead free Suprapur MERCK)
- Hydrogen Peroxide (Lead free MERCK)
- Digestion Assembly (Closed Reflux)
- Volumetric Flask
- Auto Pipette (100µl-1000µl)
- Auto Pipette (20µl-200µl)

Equipment used

a. Closed Digestion Assembly
b. Oven capable of maintaining medium 120°C-150°C
c. Atomic Absorption Spectrometer with graphite furnace. (Make – GBC, Model-932 Plus)

Lead Stock Solution

Stock standard solution of 1000 ppm of Lead Standard Solution, traceable to Standard Reference Method (SRM) from National Institute of Standards and Technology (NIST).

Preparation of Working Standard Solution (by serial Dilution) of Lead in 0.1 M HNO_3

a. 100ppm by diluting 10ml; 1000ppm stock solution to 100ml
b. 10ppm by diluting 10ml; 100ppm working solution to 100ml
c. 1ppm by diluting 10ml; 10ppm working solution to 100ml
d. 100ppb by diluting 10ml; 1ppm working solution to 100ml
e. Working standard of 5ppb, 10ppb, 20ppb, 30ppb are subsequently prepared by diluting 5ml, 10ml, 20ml, and 30ml of 100ppb stock standard to 100ml for preparation of calibration curve.

Sample Preparation

Take approximately 0.1 gm of sample on a glass slide and place it in an oven at 120°C for 2 hours. Take approximately 0.1 gm of the dried sample and weigh accurately into a closed Teflon vessel. Add 3ml of concentrated HNO_3 and place in an oven at 150°C for 1 hour. Allow the vessel and contents to cool to room temperature and transfer the solution and any precipitate that is present to a 25 ml volumetric flask. Dilute to volume with de-ionized water and mix. Allow any precipitate to settle or filter the solution and prepare a sample-blank simultaneously.

Analysis determines the concentration of lead in the samples using the solutions and standards into the Graphite Furnace Atomic Absorption Spectrometry. If the dilution is needed, fitting within calibration curve is also ensured.

Calculations

Lead as Pb (ppm) = [(concentration of Pb in sample –blank) x dilution factor]/Sample weight in grams

(Recovery was between (80-120) percent for different groups for digestion)

3. Results and Discussion

3.1 Result

The result of the analysis is presented in table 3.1,which signifies the detail analyzed content of lead in different children's metal jewellery in parts per million and its percentage by mass.

Table 3.1- Detail analysis of samples and results in ppm and its percentage by mass

S No.	Sample ID	Detail	Sample weight	Analysis amount	Results	
					(ppm)	% by mass
1	CJ-1	Bracelet- stretchable (spring) with tussles	0.1114	0.1112	15.16	0.0015
2	CJ-2	Bangle- sky blue colour	0.1654	0.1605	39688.47	3.97
3	CJ-3	Bracelet- twisted, oxidized	0.1134	0.1127	12.68	0.0013
4	CJ-4	Bracelet- square shaped in purple colour	0.1151	0.1002	1401.20	0.14
5	CJ-5	Ear ring- dangling pink in colour	0.1124	0.1080	585740.74	58.57
6	CJ-6	Ear ring- shape of a sweet, black and red in colour	0.1437	0.1310	736755.73	73.68
7	CJ-7	Ear ring- shape of a sweet (without paint)	0.1229	0.1172	611156.14	61.12
8	CJ-8	Chain- pink colour butterfly	0.1240	0.1236	203.38	0.02
9	CJ-9	Chain- chain with flower shaped pendant	0.1138	0.1137	44.05	0.0044
10	CJ -10	Ring- Flower shaped, multi coloured stones	0.1264	0.1244	177431.67	17.74
11	CJ-11	Small hoops*	0.1088	0.1085	77.62	0.008
12	CJ-12	Big Hoops (Pink)*	0.1243	0.0997	46.42	0.005
13	CJ-13	Blue Dress shaped Ear Rings*	0.1203	0.1153	10699.05	1.070
14	CJ-14	Red Coloured Sandals shaped Ear Rings*	0.0951	0.0936	42.14	0.004
15	CJ-15	Pink Coloured Shoe shaped Ear Rings*	0.1124	0.1076	508712.8	50.871
16	CJ-16	Pink Coloured Chappal shaped Ear Rings*	0.1104	0.1005	33808.46	3.381
17	CJ-17	Blue Hanging Ear rings*	0.1256	0.1248	62333.73	6.233
18	CJ-18	Heart and Flower Shaped Ear rings*	0.1089	0.1081	89.62	0.009
19	CJ-19	Teddy Ear rings*	0.1129	0.1086	283379.4	28.338
20	CJ –20	Multi coloured bangle	0.1123	0.1105	589.10	0.059
21	CJ –21	White stone Bangle	0.1184	0.1175	30.10	0.003
22	CJ –22	Yellow coloured bracelet	0.1061	0.1056	13.72	0.001
23	CJ –23	Blue coloured bracelet	0.1013	0.1010	20.33	0.002

S No.	Sample ID	Detail	Sample weight	Analysis amount	Results	
					(ppm)	% by mass
24	CJ –24	Multi (BRY) coloured bracelet	0.1232	0.1226	62.80	0.006
25	CJ –25	Multi (BPB) coloured bracelet	0.1069	0.1065	171.12	0.017
26	CJ –26	Chain with Pendent	0.1154	0.1145	10054.59	1.005
27	CJ-27	Pink Bangle	0.0990	0.0986	14.71	0.002
28	CJ-28	Yellow Bangle	0.0920	0.0916	49.67	0.005
29	CJ-29	Red Bangle	0.1363	0.1359	46.17	0.005
30	CJ-30	Multi Coloured stones Bangle	0.1049	0.1047	257.40	0.026
31	CJ-31	Yellow coloured bracelet	0.1140	0.1133	163.28	0.016
32	CJ-32	Black coloured bracelet	0.1102	0.1098	40.07	0.004
33	CJ-33	Multi coloured charms (bracelet)	0.1219	0.1215	343415.64	34.342
34	CJ-34	Bronze and silver bangle	0.1032	0.1028	333.60	0.033
35	CJ-35	Dolphins Bangle	0.1032	0.1062	179.14	0.018
36	CJ –36	Silver chain with pendant	0.1087	0.1084	14690.96	1.469
37	CJ –37	Pink and silver coloured chain	0.1234	0.1230	91.87	0.009
38	CJ –38	Chain with kitty pendant	0.1092	0.1089	235.31	0.024
39	CJ –39	Chain with oval shape design	0.1135	0.1132	116.17	0.012
40	CJ –40	Chain with maroon pendant	0.1183	0.1180	69.07	0.007
41	CJ –41	Chain with blue pendant	0.1046	0.1046	107.25	0.011
42	CJ –42	Gold coloured chain with white and gold pendant	0.1057	0.1050	195.95	0.020
43	CJ –43	Chain with heart shaped pendant	0.1059	0.1056	76.70	0.008
44	CJ –44	Chain- Y2K	0.0979	0.0974	68.28	0.007
45	CJ –45	Bangle with silver balls	0.1153	0.1149	685.38	0.069
46	CJ –46	Dark Blue ring	0.1147	0.1143	38.50	0.004
47	CJ –47	Turquoise ring	0.924	0.0920	179.35	0.018
48	CJ –48	Silver coloured ring with blue design	0.1101	0.1098	1889.80	0.189
49	CJ –49	Pink coloured ring	0.1074	0.1071	667.37	0.067
50	CJ –50	Gold coloured ring with pink stone (small)	0.1036	0.1032	856346.90	85.635
51	CJ –51	Gold coloured ring with big pink stone	0.1083	0.1080	826.39	0.083
52	CJ -52	Sliver coloured ring with yellow stone	0.0967	0.0963	413.29	0.041
53	CJ -53	Silver coloured ring with black stones	0.1259	0.1249	637309.85	63.731
54	CJ -54	Sliver coloured ring with spiral design	0.1001	0.0997	1376.63	0.138

*-In Pair

Table 3.2- Percentage of samples having lead content more than 90 ppm, 300ppm and 1000 ppm

	Above 90 PPM	Above 300 PPM	Above 1000 PPM
Bracelet	40%	10%	10%
Ear Ring	80%	80%	80%
Bangles	60%	40%	10%
Chain	67%	17%	17%
Ring	90%	80%	50%
Hoop	0%	0%	0%

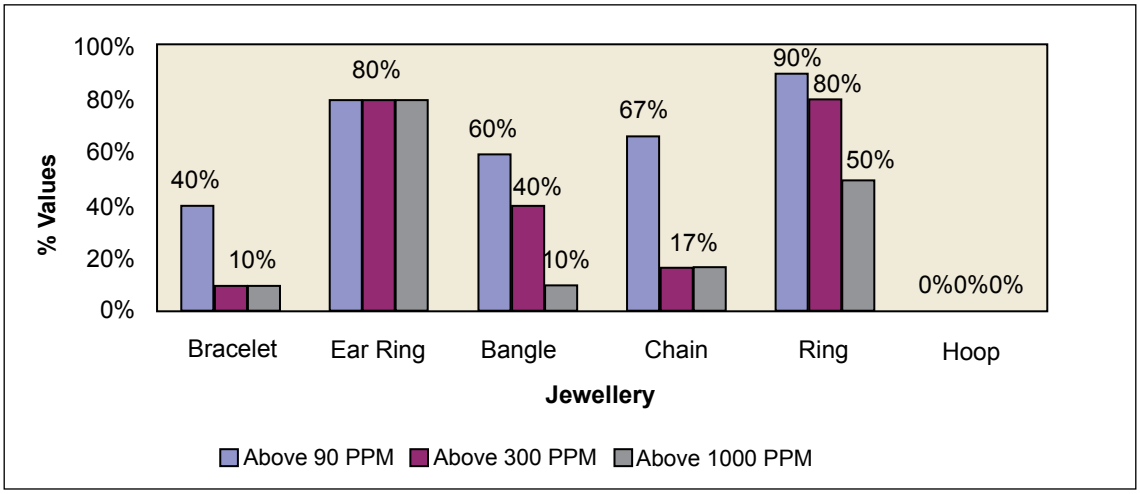

Figure 3.1– Percentage wise lead content in different articles, which are more than 90 ppm, 300ppm, and 1000 ppm

Table 3.3 – Mean values of lead content in different children's metallic Jewellery

Sample	Result by ppm and percentage	Mean	Min	Max	SD*
Bracelet	Result (ppm)	34531.60	12.68	343415.64	108531.62
	Result % by mass	3.45	0.001	34.34	10.85
Bangle	Result (ppm)	4187.37	14.71	39688.47	12476.05
	Result % by mass	0.42	0.002	3.97	1.25
Necklace/Chain	Result (ppm)	2162.80	44.05	14690.96	4870.81
	Result % by mass	0.22	0.0044	1.47	0.49
Ring	Result (ppm)	167647.98	38.5	856346.90	314452.65
	Result % by mass	16.76	0.004	85.64	31.45
Hoops	Result (ppm)	62.02	46.42	77.62	22.06
	Result % by mass	0.01	0.005	0.01	0.00
Ear Ring	Result (ppm)	283271.78	42.14	736755.73	298369.57
	Result % by mass	28.33	0.004	73.68	29.84

* Standard Deviation: $SD=\sqrt{[\Sigma (X-M)^2/ n-1]}$, Where, Σ = Sum of; X = Individual score; M = Mean of all scores; n = Sample size (Number of scores)

3.2 Discussion

Total 54 random samples of children's metal jewellery were collected from different markets, to assess the amount of lead content in it. Among total 54 samples, there were 10 bracelets, 10 earrings, 10 bangles, 12 chains, 10 rings, and 2 hoops.

Among bracelet samples, it was found that the lead content varied from 12.68 ppm to 343415.64 ppm, in which the twisted oxidised bracelet had the lowest (12.68 ppm) lead content where as the maximum lead was found in the multi coloured charms bracelet i.e. 343415.64 ppm. Out of total 10 bracelet samples, 40 percent (4 samples) samples contained more than 90 ppm, 10 percent (1 sample) samples contained more than 300ppm, and 10 percent (1 sample) samples contained more than 1000 ppm lead content. (Table 3.2, Fig 3.1)

Among earring samples, the amount of lead varied from 42.14 ppm to 736755.73 ppm, of which the red coloured sandal shaped earrings had the lowest lead concentration (42.14 ppm), while the highest lead content was found in ear ring sample in the shape of a sweet, black and red in colour i.e. 736755.73 ppm. 80 percent (8 samples) of earring samples contained more than 90 ppm, 300 ppm as well as 1000 ppm of lead content. (Table 3.2, Fig 3.1)

In bangle samples, it was found that the lead content varied from 14.71 ppm to as high as39688.47ppm, of which the pink bangle sample had the least (14.71 ppm) lead content where as the highest lead content was found in sky blue colour, i.e. 39688.47ppm. 60 percent (6 samples) of the bangle samples contained more than 90 ppm, 40 percent (4 samples) samples contained more than 300-ppm lead while 10 percent (1 sample) samples contained more than 1000 ppm of lead. (Table 3.2, Fig 3.1)

Similarly, in chain/necklace samples, the lead content varied from 44.05 ppm to 14690.96 ppm, of which, the chain with flower shaped pendant had the least (44.05 ppm) lead content where as high lead content was found in silver chain with pendant, i.e. 14690.96 ppm. 67 percent (8 samples) of chain/necklace samples contained more than 90 ppm, while17 percent (2 samples) samples contained more than 300 ppm as well as 1000 ppm of lead content. (Table 3.2, Fig 3.1)

Among the ring samples, it was found that the lead content varied from 38.5 ppm to 856346.90 ppm, in which the lowest lead content (38.5 ppm) was found in the dark blue ring sample, where as maximum lead content was found in gold coloured ring with pink stone, i.e. 856346.90 ppm. 90 percent (9 samples) of ring samples contained more than 90 ppm, 80 percent (8 samples) samples contained more than 300 ppm of lead, and 50 percent (5 samples) samples contained more than 1000 ppm. (Table 3.2, Fig 3.1)

In Hoops' samples, it was found that the lead content varied from 46.42 ppm to 77.62 ppm. Of the samples, the big hoop, pink in colour had the least (46.42 ppm) concentration of lead while the highest lead content was found in a small hoop, i.e. 77.62 ppm. Thankfully, none of the hoop samples have found excess lead contents than 90, 300, and 1000 ppm (Table 3.2, Fig 3.1).

From the above findings, it can be stated that there are variations in lead concentration in the tested samples, which is firstly due to lead based paint used in the sample and secondly due to the weight of the sample. Majority of the samples that were coated with paint and were more in weight had high lead concentration and vice-versa. However, this does not hold true for some samples, as wide variations have been found

in similar type of samples. For instance, out of the total number of samples, sample number CJ-50 (gold coloured ring with pink stone (small)) had the highest lead concentration (856346.90 ppm), whereas a very similar sample, CJ-51 (another gold coloured ring with pink stone) had low lead concentration (826.39 ppm) in comparison to CJ-50, which indicates that different suppliers have different production lots. The variations in the samples also indicate that alternates to lead are also available in the market.

3.3 Findings

1. All 54 children's jewellery samples contain lead in varied range.
2. The lead level varied from a min of 12.68 ppm to a max of 856346.9 ppm, while the average lead level has been recorded at 91156.76 ppm.
3. 65 percent (35 out of 54) jewellery samples have lead level more than 90 ppm, 43 percent (23 out of 54) jewellery samples have lead level more than 300 ppm, and 31.5 percent (17 out of 54) jewellery samples have lead level more than 1000 ppm.
4. Among the total number of samples tested, ring samples contain the highest amount of lead, i.e. 856346.9 ppm.
5. Ring samples; despite being small in size contain high level of lead, which indicates that lead is used as a malleable material and for giving better shape to the jewellery items.
6. Across all 54 samples, lead concentration is found higher in samples that have decorative colours on it, especially multi-colour.
7. Pink is the most common colour found in all sample groups and such samples suggest high lead levels.
8. Not only coloured jewellery samples show high lead level but also non-coated colourless jewellery samples show high content of lead, which clearly indicates that the jewellery item itself contains lead.

4. Conclusion

Metal jewellery comes in various shapes and sizes with each item being treated individually at the time of manufacturing. (There may be significant difference in levels of accessible lead in different components of a jewellery item.). At the time of manufacturing, jewellery items are separated into different types of components. One of the components acts as a representative for a number of component types, which is tested individually for analysis. Surprisingly, manufacturers purposely use lead in the form of a metal for many different products like bracelet, necklace, rings etc that enables easy casting, shaping, and joining of lead products. Reason being, lead possesses general physical properties of other metals and acts as a conductor of electricity and heat. It also has low melting temperature (327° C) and extreme malleability.

Of the 54 samples of children's jewellery tested, twenty three samples have been found to contain lead more than the CPSC recommended international safety limit of 0.03 percent, of which the maximum (85.635 percent) was observed in gold coloured ring with pink stone (Table 3.1). From the study it can be concluded that, the ring had the maximum amount of lead in it, followed by earrings, chains/necklaces, bangles, hoops, and bracelets. These are capable of causing lead poisoning, threatening the health of a child. Therefore it can be said that there is an urgent need to quantify and take quick action on such issues to secure children and environmental health.

In Order of High Lead Contents

Ring>Ear Ring>Chain>Bangles>Hoop>Bracelet

5. Recommendations

On the basis of the findings, collated with background information on lead and its adversarial impact on children's health, we present a few recommendations:

1. National mandatory standards/guidelines are required for limiting lead levels in paints, pigments, varnish etc, and upstream products like jewellery. (No lead should be allowed to be added at any stage of the manufacturing process)
2. Regulate trade of imported jewellery. Ensure exported consignments are within safe limits.
3. Warning labels should be put on packets containing such products.
4. Awareness among stakeholders.
5. Promotion of eco friendly non-toxic material in products.
6. Technology assistance to be provided to manufacturers, especially in the small and tiny scale sector, who may need it.

In all, it can be stated that products such as children's jewellery must not contain lead. Standards, which protect health and the environment, need to be set and made mandatory. In case technology assistance is needed, it should be provided to small-scale manufacturers. Also prime materials like paints, pigments and varnishes need to have no lead added to them to ensure that they are safer and are not dispersed through products where they are used.

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Annexure I

List of samples sent to Delhi Test House for Lead analysis

S No.	Sample ID	Description
1	CJ-1	Bracelet- stretchable (spring) with tussles
2	CJ-2	Bangle- sky blue colour
3	CJ-3	Bracelet- twisted, oxidized
4	CJ-4	Bracelet- square shaped in purple colour
5	CJ-5	Ear ring- dangling pink in colour
6	CJ-6	Ear ring- shape of a sweet, black and red in colour
7	CJ-7	Ear ring- shape of a sweet (without paint)
8	CJ-8	Chain- pink colour butterfly
9	CJ-9	Chain- chain with flower shaped pendant
10	CJ -10	Ring- Flower shaped, multi coloured stones
11	CJ-11	Small hoops*
12	CJ-12	Big Hoops (Pink)*
13	CJ-13	Blue Dress shaped Ear Rings*
14	CJ-14	Red Coloured Sandals shaped Ear Rings*
15	CJ-15	Pink Coloured Shoe shaped Ear Rings*
16	CJ-16	Pink Coloured Chappal shaped Ear Rings*
17	CJ-17	Blue Hanging Ear rings*
18	CJ-18	Heart and Flower Shaped Ear rings*
19	CJ-19	Teddy Ear rings*
20	CJ –20	Multi coloured bangle
21	CJ –21	White stone Bangle
22	CJ –22	Yellow coloured bracelet
23	CJ –23	Blue coloured bracelet
24	CJ –24	Multi (BRY) coloured bracelet
25	CJ –25	Multi (BPB) coloured bracelet
26	CJ –26	Chain with Pendent
27	CJ-27	Pink Bangle
28	CJ-28	Yellow Bangle
29	CJ-29	Red Bangle

S No.	Sample ID	Description
30	CJ-30	Multi Coloured stones Bangle
31	CJ-31	Yellow coloured bracelet
32	CJ-32	Black coloured bracelet
33	CJ-33	Multi coloured charms (bracelet)
34	CJ-34	Bronze and silver bangle
35	CJ-35	Dolphins Bangle
36	CJ –36	Silver chain with pendant
37	CJ –37	Pink and silver coloured chain
38	CJ –38	Chain with kitty pendant
39	CJ –39	Chain with oval shape design
40	CJ –40	Chain with maroon pendant
41	CJ –41	Chain with blue pendant
42	CJ –42	Gold coloured chain with white and gold pendant
43	CJ –43	Chain with heart shaped pendant
44	CJ –44	Chain- Y2K
45	CJ –45	Bangle with silver balls
46	CJ –46	Dark Blue ring
47	CJ –47	Turquoise ring
48	CJ –48	Silver coloured ring with blue design
49	CJ –49	Pink coloured ring
50	CJ –50	Gold coloured ring with pink stone (small)
51	CJ –51	Gold coloured ring with big pink stone
52	CJ -52	Sliver coloured ring with yellow stone
53	CJ -53	Silver coloured ring with black stones
54	CJ -54	Sliver coloured ring with spiral design