# Study: Lead in plastics, general household items and toys in Broken Hill

## Background to study

Lead can be found in toys and other household / consumer-based products and interior and exterior paint in homes and buildings built before the 1970s across Australia. Lead may be used in two aspects of manufacturing of these products:

1. **Paint:** Lead may be found in the paint on toys and other household items in addition to interior and interior surfaces in homes and buildings built before the 1970s.
    - In the 1970s lead was banned in house paint, on products marketed to children, and in dishes or cookware, but it is still widely used in other countries and therefore can still be found in or on imported toys.
    - It may also be found on older, antique and collectible items and toys passed down through generations.
    - Lead paint was used in most homes built in Australia before 1970. Lead paint can be dangerous when it flakes off in large pieces or breaks down into smaller chips or dust. These dangers increase during renovations when old paint is removed or disturbed from surfaces.
2. **Plastic:** The use of lead in plastics has not been banned.
    - Lead softens the plastic and makes it more flexible so that it can go back to its original shape.
    - It may also be used in plastic toys to stabilize molecules from heat.
    - When the plastic is exposed to substances such as sunlight, air, and detergents the chemical bond between the lead and plastics breaks down and forms dust.

In Australia, the maximum allowable level of lead which could enter the body under certain conditions - such as during chewing, sucking or swallowing in children's toys and finger paints - is 90 mg/kg and 25 mg/kg respectively.1

In Broken Hill, high lead levels – above the maximum allowable level - were found on a deteriorated trampoline mat by Maari Ma Health Aboriginal Corporation and Broken Hill Environmental Lead Program (BHELP) staff, whilst undertaking a home assessment of a child identified with elevated blood lead levels. It should be noted, that it was unclear if the high lead levels were from the manufacturing of the mat or from deposited environmental dust.

In response, the BHELP Steering Committee endorsed an internal study to investigate lead levels in plastics, toys and other household consumable items in Broken Hill to determine whether these should be routinely screened during home assessments - in addition to painted interior and exterior surfaces - in homes of children with elevated blood lead levels.

## Summary of findings and recommendations for parents and caregivers

Eighty-eight items were screened – including 4 furnishings, 14 general household, 20 PVC pipe and 50 toys. Twelve items (14%) had average lead levels greater than the maximum amount of lead allowed in children's toys (90 mg/kg). A further six (7%) were classified as 'high lead' when more stringent criteria were applied (average lead levels of 90 mg/kg or less but at least one reading exceeding, or potentially exceeding, 90 mg/kg). Of the seventy-six items with average lead levels of 90 mg/kg lead or less, 70 had average lead levels within guidelines for finger paints (maximum 25 mg/kg lead).

The items with the highest lead levels were old PVC pipe, one piece of which averaged 2.5% lead and had a maximum lead reading of 4.84% on a dark grey section which had been most exposed to sun. A plastic tricycle was also found with extremely high lead levels on the rubber tyres (4,965 – 8,295 mg/kg) but less than 10 mg/kg on other areas, and a "Hot Wheels" orange toy car, with high lead levels on the roof (389 mg/kg) but very low levels on other parts of the car.

While lead levels were found to be generally low in the toys and other goods screened, it is recommended that lead levels in toys and PVC be screened during home assessments if children have high blood lead levels and other sources of exposure can't be identified.

Lead is invisible to the naked eye, has no smell and has a sweet flavour. Children may be exposed to it from toys and other consumer products through normal hand-to-mouth activity, which is part of their development - they often put toys, fingers, and other objects in their mouth, exposing themselves to lead paint or dust. It should be noted that high lead levels in an object do not necessarily mean that it poses a significant lead exposure risk. If the object is not degraded or easily chewed or swallowed it would pose minimal risk.

Parents and caregivers of Broken Hill children should:

- Always wash their hands before eating, after playing outside and after playing with toys
- Regularly clean children's toys play equipment and other household items
- Discourage children from sucking or placing toys and other household items in their mouth
- Keep children away from flaking, chipping and deteriorating old painted surfaces in and around the home – safely remove or cover up the surface
- Make sure your children attend free scheduled testing between 0- 4 years. Most children with elevated blood lead levels have no symptoms. The only way to tell is to have a blood lead test. Free blood lead testing is offered for all children in Broken Hill aged 0-4 years.

## Method of study

Toys and consumable household items were sourced from a range of locations, including staff homes, workmates, Maari Ma Health Aboriginal Corporation, friends and the Lifeline Tip Shop.

BHELP staff screened items using the Olympus Delta field portable XRF in 'consumer' mode. The calibration check coin and relevant standards (EC 681K for consumer mode and SRM 2570 and SRM 2573 for paint mode) were read before each sampling session to ensure the XRF was functioning properly.

Each item was read 3 times, for 30 seconds each reading, which is the default setting for 'consumer' mode. Readings were taken from flat areas where the front of the XRF could be placed flush against

the item. If items were made up of different colours or types of materials, readings were taken of up to 3 different colours or types.

Items were classified as 'furnishings' (chair, seat cushions, blinds), 'general household' (feed bucket, adult bicycles, clothes pegs, solar lamp, cistern etc), 'PVC pipe', and 'toys'. XRF results and uncertainty values for each reading were entered in an Excel spreadsheet, and average result and uncertainty value calculated for each item.

Pivot tables were used to calculate the number of items with results meeting the following criteria. In order of increasing rigour, these were:

1. Average reading ≤ 25 mg/kg, 26-90 mg/kg, ≥ 101 mg/kg;
2. Any reading above 90 mg/kg;
3. Any reading potentially above 90 mg/kg (i.e., where the reading plus it's uncertainty value exceeded 90 mg/kg).

## Results and discussion

Eighty-eight items were screened (4 furnishings, 14 general household, 20 PVC pipe, 50 toys). Most items had average lead levels of 25 mg/kg or less (Table 1, Figure 1) and thus posed very low risk of lead exposure. However, very high lead levels were found in some items (Table 2), particularly old PVC pipe, one piece of which averaged 2.5% lead and had a maximum lead reading of 4.84% on a dark grey section which had been most exposed to sun. Two toy items also had high average lead levels: a plastic tricycle with extremely high lead levels on the rubber tyres (4,965 – 8,295 mg/kg) but less than 10 mg/kg on other areas, and a "Hot Wheels" orange toy car, which had high lead levels on the roof (389 mg/kg) but very low levels on other parts of the car.

When the more conservative criteria of "any reading above 90 mg/kg" or "any reading potentially above 90 mg/kg" were used rather than "average reading above 90 mg/kg", 6 further items were classified as having elevated lead levels (Tables 1, 3 & 4). Three of these were toys: a plastic 'ray' gun with levels less than 10 mg/kg on two sections but 143 mg/kg on a third, and a "Tonka" truck and "Hot Wheels" lid which both had estimated lead levels below 10 mg/kg but unusually high uncertainty readings (up to 117 mg/kg) which meant they potentially had high lead levels. Because the items with high uncertainty values were painted, they were screened again using the XRF in 'paint' mode, and no lead was detected. The reason for the very high uncertainty values for these items is unknown; both were metal and it may be that the XRF calibration does not cope well with that particular type of metal.

It should be noted that high lead levels in an object do not necessarily mean that it poses a significant lead exposure risk. If the object is not degraded or easily chewed or swallowed it would pose minimal risk. Some of the old PVC pipe was corroded and handling it left a visible pale chalky residue on hands which poses a potential lead exposure pathway. In contrast, the rubber tyres on the old tricycle, which were also found to have very high lead levels, did not appear to leave a residue when handled. Similarly, plastics which break down into small pieces when degraded, such as trampoline mat, could pose an exposure risk when degraded if they have high lead levels.

Table 1: Summary statistics by item group.

| | Furnishings | General household | PVC pipe | Toys |
|---|---|---|---|---|
| Number sampled | 4 | 14 | 20 | 50 |
| Average Pb level (mg/kg) | 65.3 | 53.9 | 3506.4 | 61.5 |
| Minimum Pb level (mg/kg) | 0 | 0 | 0 | 0 |
| Maximum Pb level (mg/kg) | 133.7 | 448.8 | 20,542.3 | 2,768.5 |
| % Average ≤ 25 mg/kg | 50.0 % | 71.4 % | 55.0 % | 94.0 % |
| % Average 26 - 90 mg/kg | 0 | 14.3 % | 15.0 % | 2.0 % |
| % items fail: | | | | |
| % Average ≥ 91 mg/kg | 50.0 % | 14.3 % | 30.0 % | 4.0 % |
| % Any reading ≥ 91 mg/kg | 50.0 % | 21.4 % | 40.0 % | 6.0 % |
| % Any reading potentially ≥ 91 mg/kg | 50.0% | 21.4 % | 40.0 % | 10.0 % |

Figure 1: Number of items whose average lead level met or failed standards for lead levels in items accessible by children by item group.

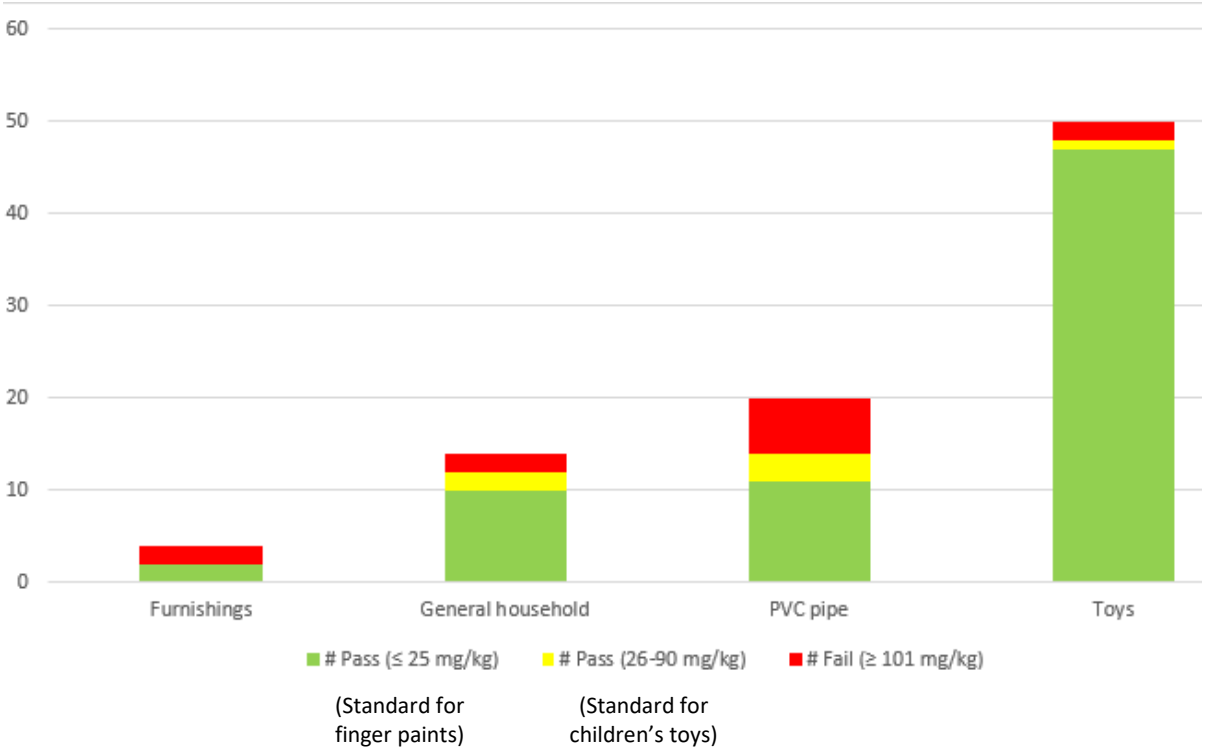


Table 2: Items with average lead levels above 90 mg/kg by item group.

| Category | Item | Comments |
|---|---|---|
| Furnishings | Green chair cushions on NPWS sundeck | Average 134 mg/kg; range 66 - 178 mg/kg. |
| | Mini venetian blinds, front office 1st floor NPWS building | Average 116 mg/kg; range112 - 127 mg/kg |
| General household | Yellow bicycle (adult) | Average 449 mg/kg; range 0 – 1,337 mg/kg. The high reading was on the handlebar covers/grips. |
| | Silver bicycle (adult) | Average 118 mg/kg; range 0 - 323 mg/kg. The high reading was on the handlebar covers/grips. |
| PVC pipe | Old, small diameter PVC pipe (about 60 mm) | Average 20,542 mg/kg; range 6,586 – 48,400 mg/kg. Highest reading on dark grey 'corroded' area which had been most exposed to sun. |
| | 110 mm sewer pipe, unwashed | Average 15,067 mg/kg; range 15,000 – 15,200 mg/kg |
| | 110 mm sewer pipe, washed | Average 14,933 mg/kg; range 14,600 – 15,200 mg/kg |
| | 90 mm PVC pipe | Average 6,936 mg/kg; range 6,838 – 7,082 mg/kg |
| | 40 mm ILEX PVC pipe | Average 6,582 mg/kg; range 6,412 – 6,794 |
| | Old PVC pipe outside NPWS sundeck fence, approx. 220 mm diameter | Average 5,823 mg/kg; range 5,732 – 5909 mg/kg. |
| Toys | Plastic tricycle | Average 2,786 mg/kg; range 3 – 8,295 mg/kg. The highest reading was on the tyre tread, a second reading on the side of the tyre confirmed the high result (4,965 mg/kg). |
| | "Hot wheels" orange car | Average 130 mg/kg; range 0 – 389 mg/kg. Highest reading on roof. |

Table 3: Items with average lead levels below 90 mg/kg but one or more individual readings above 90 mg/cm$^2$

| Category | Item | Comments |
|---|---|---|
| General household | Horse feed bucket | Average 89.9 mg/kg; range 82.5 – 93.7 mg/kg |
| PVC Pipe | 38 mm connector | Average 89.5 mg/kg; range 0 – 212 mg/kg |
| | Sewer flange | Average 70.3 mg/kg; range 0 – 202 mg/kg |
| Toys | Silver ray gun | Average 50.8 mg/kg; range 2.8 – 143 mg/kg. High reading on orange section. |

Table 4: Items with average lead levels below 90 mg/kg but one or more individual readings potentially above 90 mg/cm$^2$

| Category | Item | Comments |
|---|---|---|
| Toys | Tonka truck | Average 2.3 mg/kg; range 0 – 7 mg/kg. Variation range 0.8 - 109 mg/kg. When checked in paint mode, no lead detected. |
| | "Hot Wheels" lid | Average 0.0 mg/kg; range 0 – 0 mg/kg. Variation range 91 – 117 mg/kg. When checked in paint mode, no lead detected. |

Consumer standard IC681K has an expected value of 98 mg/kg ± 6.[2] The average reading of this standard by the XRF was 93 mg/kg (n = 6, range 91.9 – 94.8), indicating the XRF was performing to expectations.

There were three limitations to this study. The first is that the shape of some objects meant that some of their component materials could not be screened because they were too small or irregularly shaped for the XRF sampling window to sit flush against them (if the sampling window does not sit flush against the object it will underestimate the amount of lead). The second limitation is that only three readings were taken from each object; some objects consisted of more than three visually different materials. Taken together, these limitations mean some high-lead levels may have been missed. The third limitation is that the XRF could only measure lead levels, and not whether they were migratable; and thus may over-estimate potential for lead exposure.

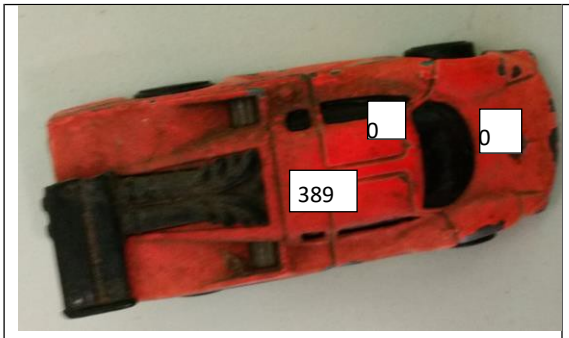
## Conclusion

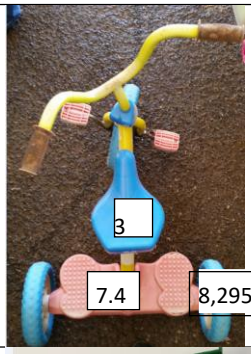
Lead levels were found to be generally low in toys and other goods in Broken Hill and routinely screening these items during home assessment isn't warranted. However, the few high results suggest that if children have elevated blood lead levels and other sources of exposure can't be identified, it would be worth checking lead levels in toys and old PVC pipe the children can access.

## References


1. Product Safety Australia. Toys containing lead and other elements. Undated. Available at https://www.productsafety.gov.au/standards/toys-containing-lead-other-elements (Accessed 13/7/2018)
2. Linsinger T, Liebich A, Przyk E, Lamberty A. Certification Report. The certification of the mass fraction of, As, Br, Cd, Cl, Cr, Hg, Pb, S and Sb and the assignment of indicative values for Sn and Zn in two polyethylene reference materials Certified Reference Materials ERM®-EC680k and ERM®-EC681k. European Commission, Joint Research Centre, Institute for Reference Materials and Measurements (IRMM) Geel (BE). Available at http://publications.jrc.ec.europa.eu/repository/bitstream/JRC37540/7540%20-%20ERM-EC680k%20%20ERM-EC681k_report_complete.pdf [Accessed 19th June 2018]

Appendix 1 – Examples of toys and other items sampled. Lead levels (mg/kg) shown in text box.



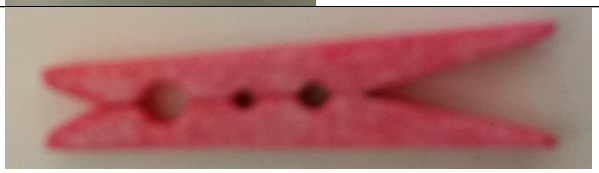




Average: 1.13
Range: 0 – 3.4

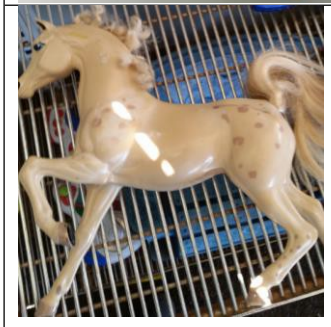

Average: 5.13
Range: 0 – 13


Average: 0.53
Range: 0 – 1.6

Average: 0.43
Range: 0 – 2.7



Average: 1
Range: 0



Average: 1.7
Range: 0 – 1.6

Average0
Range: 0