Lead in Australian Children: Summary of the National Survey of Lead in Children

conducted by the Australian Institute of Health & Welfare
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This document is a plain language summary of the report on the National Survey of Lead in Children carried out by the Australian Institute of Health and Welfare. It has been prepared by the Environment Protection Agency for distribution to members of the public who are interested in the results of the survey.
A copy of the full report can be obtained from the Australian Government Publishing Service for a nominal charge.

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Background

Lead is a naturally occurring metal and can be dispersed in the environment by natural processes such as weathering of the earth's surface, volcanic activity and forest fires. It has also been used by people for thousands of years, especially since the industrial revolution. Lead particles resulting from various industrial processes and both industrial and domestic uses can accumulate in household dust, water and soil. In mining towns lead may be present naturally in the soil.

It has long been known that lead can be poisonous for humans and animals if it enters the body in sufficiently high doses. Severe lead poisoning is now rare, but over the past twenty years there has been increased attention on the possible effects of low-level exposure on the intellectual development (IQ) of babies and young children. In

addition, children are at greater risk of lead exposure. This is because of the tendency of young children to place objects in their mouths, suck fingers and eat soil, and because the metabolism of young children increases lead uptake.

The concentration of lead in the bloodstream has been accepted as a good measure of exposure to lead. Extensive studies have been carried out in a number of countries to try and understand the effect of low doses of lead on intellectual development. The results of these studies indicate that blood lead levels of greater than 10-15µg/dL can affect intellectual development. At lower levels the effect of lead is more difficult to determine because of other factors affecting development.

Sources of lead exposure

Some possible sources of lead in the environment that may lead to elevated blood lead levels are shown in Box 1.

National goals for reduced blood lead levels

In 1993 the National Health and Medical Research Council (NHMRC) emphasised its concern over exposure to lead, especially in young children, and recommended that a blood lead level of less than 10 µg/dL should be achieved for all Australians. The NHMRC recommended targets for reduction of blood lead levels by the end of 1998, as follows:

- 15 µg/dL for all Australians (with the exception of occupational exposures); and
- 90% of all children from 1-4 years having blood levels of below 10 µg/dL. An explanation of the units used to measure blood levels is given in Box 2.

Sources of lead

- Lead in petrol - all new Australian vehicles since 1986 have used unleaded petrol; however, in 1995 about 43% of petrol sold still contained lead.
- Lead-based house paint - before 1950 many Australian paints contained as much as 50% lead and high levels persisted even after the replacement of much of the lead by titanium oxide in exterior wall paints. In 1965 the NHMRC uniform paint schedules recommended a maximum lead content of 1% for domestic paint; the maximum allowable concentration in paints today is 0.25%.
- Food - dietary intake of lead has been shown to be extremely low in Australia (Australian Market Basket Survey, National Food Authority 1992). Lead soldered cans are rare in Australia (unusual shapes only); some imported cans are still lead soldered but this is not regarded as a significant hazard.
- Auto enamel paints, lacquers, driers and anti-corrosive primers.
- Lead industry (smelter and mining activities) - source of lead exposure for local community.
- Various hobbies - stained glass and lead-lighting; pottery (lead glazes); casting lead weights for fishing; indoor pistol shooting.
- Cigarette smoke.
- Contaminated dust, soil and water.

Units

In common with much previous public health documentation, in this summary blood lead levels are expressed as micrograms per decilitre, or **µg/dL** (where 1 dL = 100

mL). Thus, the blood levels referred to here represent very low concentrations indeed, for example 10 µg/dL is equivalent to 0.1 part per million (ppm).

In modern laboratory practice, however, blood lead levels are usually expressed as micromoles per litre (µmol/L). Particular values for µg/dL used in this summary convert as follows:

10 µg/dL = 0.48 µmol/L; 15 µg/dL = 0.73 µmol/L; 25 µg/dL = 1.21 µmol/L.

Strategy to reduce lead levels

In July 1993 a Roundtable Conference of government, industry and community representatives was convened by the Minister for Environment, Sport and Territories to decide upon a national strategy to reduce lead levels.

In order to determine existing blood lead levels in the Australian community it was recognised by both the NHMRC and the Roundtable Conference that a national survey was required. Funding for the project was included in the 1993-94 budget to the Environment Protection Agency (EPA) an agency of the federal Department of the Environment. The EPA, in consultation with the Department of Health and Family Services, commissioned the Australian Institute of Health and Welfare (AIHW) to conduct a nationwide survey - National Survey of Lead in Children - of blood lead levels in a representative sample of children aged 1 to 4 years.

National Survey of Lead in Children

Aims

- to measure the blood lead levels in a representative sample of Australian children aged 1 to 4 years;
- to use the findings of the survey to assist further assessment and management of risks; and
- to provide baseline information for the Australian population against which the effectiveness of risk-reduction strategies may be assessed.

Methods

1. Sampling

To ensure that the survey was representative of the whole Australian population, an area-based random sample of Australian Bureau of Statistics (ABS) census districts (CDs) was used in which every household had the same probability of being selected. It was calculated that the number of blood tests required to achieve survey objectives was a minimum of 1000 and preferably 2000-2500.

Fieldwork was carried out by specifically trained interviewers who had previous experience with the ABS. A pilot survey was carried out in South Australia in September 1994. The main survey was carried out in February and March 1995.

2. Pre-survey information

Initially a media release solicited community support for the project and listed the survey locations. Pamphlets were then delivered to all houses in the selected areas describing what would be involved in the survey. These pamphlets included information in English and seven other languages; interpreter services were offered. Subsequently, additional information was provided explaining the adverse effects of lead in children, sources of environmental lead and how exposure can be minimised.

3. Collection of household information

The first visit of the interviewer identified which households had children. Where there were eligible children, information was collected about the occupants, characteristics and age of the residence, condition of paintwork, proximity to major roads and other relevant environmental information.

4. Blood sampling and collection of environmental specimens

If the parents agreed to a blood sample being taken from their child a further visit was arranged in which the interviewer was accompanied by a skilled paediatric blood collector. At this visit further information was collected on a questionnaire and the blood sample(s) taken. Other environmental samples (dust, water, paint, soil) were also collected.

5. Equipment used and laboratory analysis of samples

Blood was analysed at Sydney's Royal North Shore Hospital. For quality control purposes one in ten of the blood specimens was also analysed at the Royal Prince Alfred Hospital also in Sydney. Royal Prince Alfred Hospital also analysed all the environmental specimens as required and tested all equipment before the survey to ensure that it was lead-free.

For all children found to have blood lead levels of greater than 15 µg/dL, a further analysis was carried out to determine the ratio of lead isotopes in the blood. This is because lead from different sources has a different isotopic composition and comparison of the isotope ratio in the blood and that in various environmental samples may allow the source of the contamination to be identified. The isotope analysis was carried out by the CSIRO Minerals Research Laboratories.

The solubility of lead in lead paint samples was also determined to assess the potential for it to be absorbed in the gastrointestinal tract of children.

6. Notification of findings

Letters were sent to all parents advising them of the results of the tests. In the small number of cases where the blood lead levels were elevated, the consent of parents for the State/Territory health authority to be notified was requested so that sources of contamination could be followed up. Family doctors were also notified if parents requested it.

7. Statistical analysis

A range of standard statistical tests were carried out on the data. This analysis showed the distribution of blood lead levels in children aged 1 to 4 years and correlated the findings with factors identified in the household information, questionnaires and environmental sampling.

To compare the average blood lead levels of children in a particular group (eg children living in rented accommodation) compared with those of children in another related group (eg children living in houses owned by parents) a form of statistical analysis was used in which the results for each variable are treated individually (single variable analysis; SVA).

Another statistical method was used to assess the effect of a combination of factors for which information was obtained (multivariable regression analysis). This method can identify associations (linear regression) and predict the likelihood of having a blood

lead level of greater than 10 µg/dL in a particular situation (logistic regression). Statistical significance in both SVA and regression analysis provides evidence that a particular factor is a reliable indicator for elevated blood lead levels.

Results

The occupants of 26,193 dwellings were contacted by interviewers. A total of 3542 children aged 1-4 years were located in 2886 households. Household information forms and/or child questionnaires were obtained from most of these households. Blood was collected from 1575 children (from 1300 households).

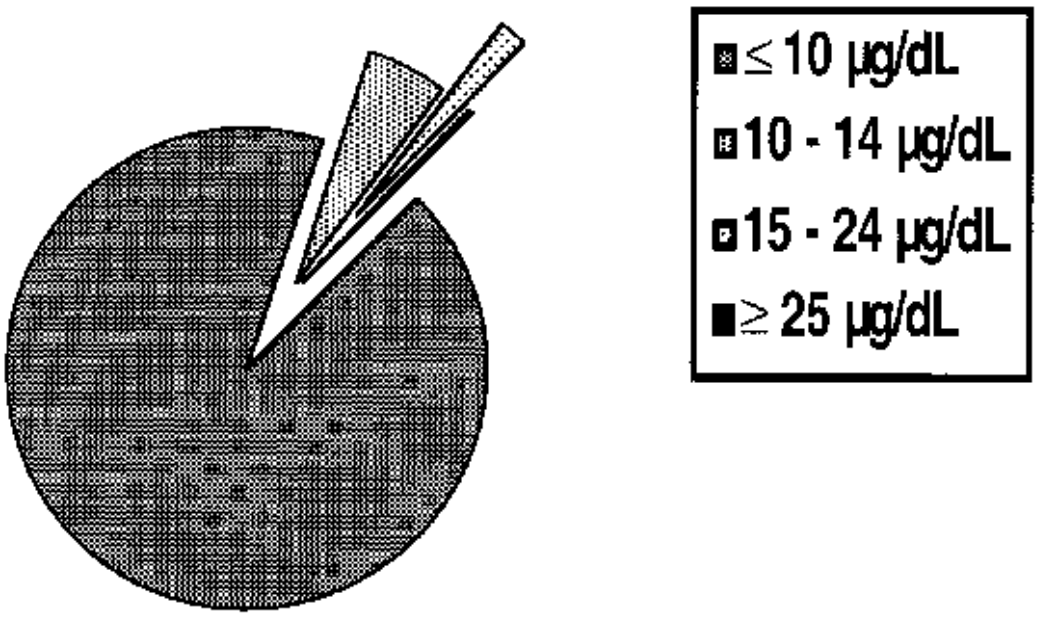
Blood lead level results for the 1575 specimens are summarised in Table 1 and Figure 1.

Table 1 Blood lead levels of children sampled, 1995

Blood lead levels					
	< 10 µg/dL	**>= 10 µg/dL**	**>= 15 µg/dL** 1	**>= 25 µg/dL** 2	**Total**
Number of children	1460	115	27	4	1575
Percentage	92.7	7.3	1.7	0.25	-

1 Notifiable to State/Territory health authority (with parents consent)
2 The highest reading was 32.7 µg/dL

Figure 1 Proportion of Australian children (1-4 years) with blood lead levels of 10 µg/dL and above, 1995



The average value (mean) for all samples was 5.8 µg/dL (0.28 µmol/L). There was a slight variation in the mean values for different States/Territories with the lowest value recorded in the Australian Capital Territory and highest in the Northern Territory, although the sample size was much lower in both these Territories.

Based on the information included in the household forms and child questionnaires the blood lead level results were assessed for a range of factors associated with the

children themselves (eg age, sex), social and economic factors, environmental factors relating to the house and surroundings, and so on.

Statistical analysis of the results showed that the following factors for which information was available had no relationship with the levels of lead in the children's blood: aboriginality, sex of child, tendency of children to suck either fingers/thumb or toys; use of childcare; ownership of pets; and consumption of home grown vegetables.

Factors that were shown to have some association with blood lead levels are shown in Table 2.

Table 2 Summary of blood lead level results

Effect on blood lead level			
Factor	**Single variable analysis (SVA)** 1	**Regression analysis**	**Comments**
Child Factors			
Age	Slight increase for 1-year-olds (12-24 months)	Significant	Increases in lead levels of younger children associated with greater tendency to be in contact with the ground and place things in their mouths
Tendency of child to eat soil	Marked increase if soil consumed every day, especially if house built before 1966 Slight increase if soil consumed occasionally (moderate if house built before 1966)	Strongly significant	
***Social and economic factors of household*<**			
Maximum individual income	Moderate increase if less than $20 000	Significant	
Higher education	Lower if degree or higher qualification	Significant	
Home ownership	Slight increase if home rented	Not significant	Increase in SVA due to other factors (income, age of house, etc)
Car ownership	Slight increase in households with cars using leaded petrol	Significant	
Smoking	Slight increases in household with smoker	Significant	Analysis of 10 brands of cigarettes showed an average lead content of 0.29 g/ cigarette
Environmental factors			
Proximity to major road	Marginal increase in households within 25m of a major road with a mean daily traffic count of > 5000 vehicles	Not Significant	Previous surveys have shown that blood lead levels of school children is elevated near main roads

Cleanliness of House (eg. dust)	Moderately to markedly lower levels in clean houses	Strongly significant	
Year of house	Moderate increases if house pre-1920 Slight increase if house built 1921-65 No effect if house built after 1966	Strongly significant	
Condition of internal paint	Moderate increase if severe chalking/ peeling of paint (marked if house pre-1966) Slight increase if some chalking/ peeling of paint		Effect due more to age and cleanliness of house
Condition of external paint	Slight increase if severe chalking/ peeling of paint	Not significant	
Renovation	Slight increase if house renovated within last 12 months (moderate if house is pre-1951)	Not significant	Age of house more important (renovation more common in older houses)
Occupation, hobbies and other factors			
Occupation	Moderate increases for lead smelting or panel beating Slight increase for automotive repair	Significant	
Hobbies	Slight - marked increases for a range of hobbies including china painting, stained glass, pottery/ ceramics, making fishing sinkers, shooting, panel beating/spray painting and automotive repairs		Individual hobbies practiced by a few households only

1 'Slight increase' refers to a mean blood lead level of 6.2 - 6.8 µg/dL (0.30-0.33 µmol/L); 'moderate increase' refers to 7.0 - 8.3 µg/dL (0.34-0.40 µmol/L); 'marked increase' refers to greater than 8.3 µg/dL (0.40 µmol/L)

Discussion

This survey of blood lead levels in children is the first systematic study of a representative sample of Australian children to have been carried out. In 1993 a National Review of Public Exposure to Lead in Australia was published by the South Australian Health Commission. The authors drew on the limited data available to make a range of estimates for blood lead levels in Australian children in 1993. Table 3 compares the lowest 1993 estimate with the 1995 survey findings. OECD figures for

1993 showed average blood lead levels of 5 µg/dL for the United States, 6 µg/dL for Canada and 7 µg/dL for the United Kingdom.

The results of the survey therefore show that lead levels in 1995 are very much lower than those estimated in 1993. Even taking into account the fact that it was clear that blood lead levels were generally decreasing in Australia (as in other countries) the actual results of the survey (with a mean blood lead level of 5.8 µg/dL) showed appreciably lower levels than had been predicted based on the limited trend data available.

Table 3 Comparison of 1993 estimates of blood lead concentrations of Australian children and 1995 survey findings

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Blood lead level	>= 10 µg/dL	>= 15 µg/dL	>= 20 µg/dL	>= 25 µg/dL
1993 low estimate 1	26%	7%	3%	1%
1995 survey result	7.3%	1.7%	0.6%	0.25%

1 Estimates were made based on extremely limited data (South Australian Health Commission 1993)

The survey results show that the NHMRC target that 90% of children should have blood lead levels below 10 µg/dL by 1998 has already been met in 1995.

Factors affecting blood lead levels

In common with many other health issues, this survey found that socially advantaged families had lower mean blood lead levels than disadvantaged families. Lead levels were lower where household income was greater than $20Ê000 and/or a household member had a degree or higher tertiary qualification. Although lead levels appeared higher in families in rented accommodation, in this case two environmental factors were more important: the greater ages of rented homes and the poorer condition of paintwork in them.
Three environmental factors that appeared to be strongly related to the blood lead levels of children in the survey were:

- cleanliness of the home;
- severely peeling interior paint; and
- year of construction of the home.

Blood lead level was also higher when a member of the household smoked or was involved in activities such as lead smelting, automotive repair, panel beating or one of a number of hobby activities involving lead (see Table 2).

Eating soil by the child was found to be strongly related to the level of lead in the blood. Lead concentrations of samples of soil, water and peeling paint were all correlated with blood lead level in the child.

Public education and guidelines for reducing low-level exposure

In 1993 the NHMRC also recommended action plans to reduce/manage blood lead levels in Australian children as follows:

- public information programs on the sources of lead in the environment, health risks, and means of controlling exposure;

- personal exposure testing for individual children with a level of equal or greater than 15 µg/dL, exposure reduction strategies and retesting;
- public health action for communities where representative samples show more than 5% of one to four year old children have blood lead levels of 15 µg/dL or above, to identify the source of exposure and develop environmental management plans to reduce levels.

The survey results indicate that public health actions to lessen exposure to lead in the home would be helpful. Reduction of dust inside the home may be particularly important and smoking in homes of young children should be discouraged. Safety measures when parents are involved in hobbies which use or disturb lead-based products, especially panel beating and renovation of old homes, are also important.

To assist households to further reduce already low lead levels, a series of fact sheets about lead have been produced by the EPA under the banner 'Lead Alert'. These fact sheets cover topics such as:

- Lead in the environment
- Lead in Recreational Activities
- Lead in Paint
- Auto paints
- Risky ceramic ware
- Lead lighting
- Pottery

The pamphlets provide useful information on basic precautions to take when using or disturbing lead-based products. These precautions aim to minimise exposure of people or the environment to lead dust or fumes.
Please call the toll-free number or write to the EPA for free copies.

The Environment Protection Agency is an Agency of the Federal Environment Department

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This document and other information on environmental lead issues can be located on Internet at:
http://www.ea.gov.au/atmosphere/airquality/lead/index.html