

Frequently asked questions

Testing and Reporting Port Pirie Children's Blood Lead Levels

SA Health publishes regular reports about the trends in Port Pirie children's blood lead levels. Click on a question below to see answers to some of the questions frequently asked on this topic.

- Q [Why are we concerned about lead in Port Pirie?](#)
- Q [Why do we collect blood samples to measure lead?](#)
- Q [How do we collect blood samples in Port Pirie?](#)
- Q [What units do we use to measure blood lead levels?](#)
- Q [Why do we test young children less than five years of age?](#)
- Q [Why do we test pregnant women?](#)
- Q [When do we test mothers and children?](#)
- Q [Why don't we test older children?](#)
- Q [Why do we regularly publish trends in children's blood lead levels?](#)
- Q [What do the measures published in the blood lead report mean?](#)
- Q [Why do we report the geometric mean?](#)
- Q [Why do we use a child's most recent blood lead result in the report: does this 'play down' high blood lead levels?](#)
- Q [Why don't we include every test result collected for each child in the report: does excluding multiple tests for some children from the dataset 'play down' the number of children at risk?](#)
- Q [Why do we include mothers' blood lead results in the report: does this 'play down' the number of children at risk?](#)
- Q [Why don't we report the highest and lowest blood lead results measured?](#)
- Q [Why do we compare the results of each reporting period from year-to-year but not between quarters?](#)
- Q [Do these reports represent all children living in Port Pirie?](#)
- Q [Why do the numbers of children sometimes vary when comparing reports from different years?](#)
- Q [Are SA Health's reporting methods valid?](#)
- Q [Why did we change from using a child's maximum test result in the report to using the most recent test result?](#)
- Q [Why has a line chart been used when data is not continuous?](#)



Why are we concerned about lead in Port Pirie?

The Port Pirie environment is contaminated with lead from more than 120 years of smelting activities in the city.

Even small amounts of lead can be toxic when ingested or inhaled. SA Health has delivered a lead abatement public health program for the Port Pirie community since 1985 to reduce lead exposure.

More information about health effects of lead can be found at:

<https://www.nhmrc.gov.au/guidelines-publications/eh58> (accessed August 2015).

Why do we collect blood samples to measure lead?

Once lead has been swallowed or inhaled and then absorbed from the gut or airways it circulates in the bloodstream. Measuring the level of lead in blood (i.e. the concentration) is the most accepted indicator (i.e. biomarker) of a person's exposure to lead during the previous five to six weeks.

Long term exposure to lead cannot be measured accurately from blood tests because lead deposits in parts of the body such as teeth and bones. Testing of teeth and bones is difficult, not widely available and the results are difficult to interpret.

How do we collect blood samples in Port Pirie?

SA Health's local Environmental Health Centre provides a voluntary blood screening program for the Port Pirie community.

Blood samples are collected from young children and pregnant women using a capillary technique. The finger is cleaned and blood is collected into a glass capillary tube from a simple finger prick. This testing method is less distressing for young children than collecting venous blood samples. So it is more likely that children will return for subsequent testing if the experience is not traumatic.

It can be difficult to clean all contamination from the finger if the skin is thick or calloused. So it may be recommended that a venous blood sample is taken to test lead levels in older children and adults.

What units do we use to measure blood lead levels?

Lead levels in blood are usually reported as micrograms per decilitre which can be shortened to $\mu\text{g/dL}$ (sometimes written as ug/dL). A decilitre is 100 millilitres. Laboratories usually also report the level as micromoles per litre shortened to $\mu\text{mol/L}$ (sometimes this is written as umol/L).

To convert micromoles per litre to micrograms per decilitre, multiply by 20.72

e.g. $0.48 \mu\text{mol/L} = 10 \mu\text{g/dL}$

Why do we test young children less than five years of age?

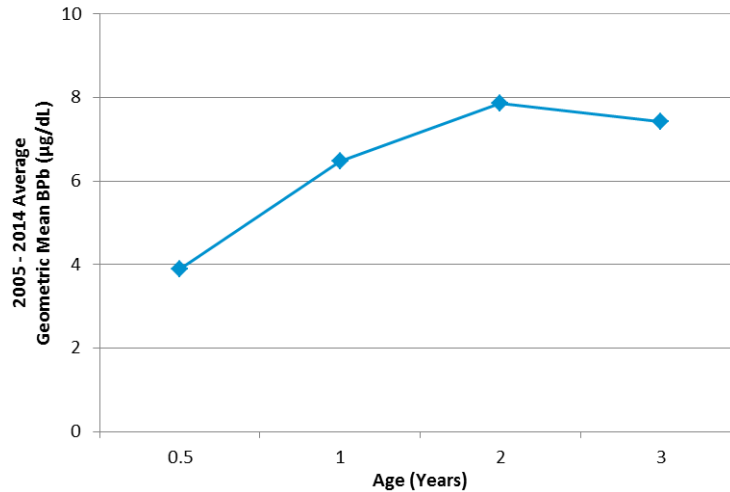
Babies and young children are at higher risk from lead because:

- > their nervous systems and brains are developing rapidly and are susceptible to damage
- > they absorb and retain greater amounts of lead than adults
- > early childhood behaviour such as crawling and playing on the floor, mouthing toys, and hand-to-mouth action increases the likelihood of young children coming into contact with surfaces around the home that can be contaminated with lead dust.

Research tells us that the steepest rise in lead exposure occurs during the first two years of life. So SA Health's lead abatement program focuses interventions to reduce lead exposure in early childhood – with particular attention on infants and toddlers less than two years of age.

After the age of two years, children start to reduce mouthing behaviour and have less contact with contaminated surfaces as they learn to walk, so their lead exposure begins to decrease. By the time children reach their third birthday their lead exposure has usually plateaued, and in most cases, reduced (see Figure 1).

Figure 1: Typical blood lead changes with age



Why do we test pregnant women?

Lead in the mother's blood passes virtually unhindered into her unborn child which can affect the baby's development. This means a baby is born with almost the same blood lead level as their mother (research shows that newborns have around 87% of their mother's level at birth).

The mother's blood lead level measured closest to the time of birth (either before or directly after) provides the baseline blood lead level for her baby.

The mother's result is also an important indicator of whether there might be any unexpected lead sources around the home that need to be removed. So it helps expectant parents prepare their homes for the new baby.

When do we test mothers and children?

Children are first tested at six months of age and then at one year, two years and three years of age, usually within one month of their birthday.

Children with elevated blood lead levels may be tested more frequently than once a year. Their test results are used to work out the right interventions to help reduce their exposure risk. Every test result is used to make sure that the most appropriate actions are taken quickly and are tailored to suit each child's changing exposure situation. But only each child's most recent blood lead result is used to generate the report (see answer to question below).

Pregnant women and women planning a pregnancy should be tested early to determine their recent lead exposure and whether there may be possible lead sources around the home that need to be removed before their baby is born. Pregnant women should also be tested close to birth (pre- or post-birth) to determine their baby's baseline lead level.

Why don't we test older children?

Children aged more than four years are less likely to be tested because their risk of lead exposure and subsequent developmental effects is reducing. After a child reaches two to three years of age their blood lead levels have usually peaked and plateaued (see Figure 1). If they have not had an elevated blood lead result it is unlikely they will go on to have a high level. In discussion with the Environmental Health Centre, parents may choose for their children not to have any more blood tests unless the home exposure risk changes, for example, the family moves to a higher lead risk area of the city or they undertake dust-generating renovations. However, children that have or are likely to have elevated levels are encouraged to keep having tests.

Public health screening programs, like Port Pirie's blood testing program, screen those people at risk of developing health effects. Older children who have had consistently low blood lead levels are considered to be low risk of lead exposure and health effects and are not routinely tested unless their exposure situation changes. As with any other medical test, children are not tested if they have a low or negligible risk.

Why do we regularly publish trends in children's blood lead levels?

We compile Port Pirie's blood lead data to monitor trends and help manage the impacts of lead on the community. This reporting is an essential part of SA Health's lead abatement public health program.

The South Australian government, Port Pirie Regional Council, Nyrstar smelter and the Port Pirie community work closely together to coordinate actions to reduce the exposure of children to lead and to identify solutions to further reduce blood lead levels. These reports provide stakeholders with an up-to-date picture of how the population of Port Pirie is being impacted by lead.

The population trends we publish allow us to monitor the effectiveness of the exposure-reduction actions taken. The report allows timely adjustments to strategies to respond to changing environmental conditions.

Population trends are a good way to keep stakeholders and the general public informed about the progress of work to reduce lead exposure in Port Pirie. However, it should be noted that the most meaningful data comparison is between calendar year to calendar year because all tested children are represented.

People's private medical information, such as individual blood test results, cannot be made publicly available as this would be a breach of confidentiality.

What do the measures published in the blood lead report mean?

Total number of children tested

This measure tells us how many children aged less than five years of age and living in Port Pirie at the time, were tested during the reporting period. If a child had more than one test in the reporting period, their most recent result was used.

When a young baby has not yet been tested, the mother's blood lead level, measured close to the time of birth, can be used as a surrogate result to represent the baby until they have their first blood test at six months of age. Once we have a test result for the baby, or it is more than nine months since the mother's test was taken, the mother's test result is no longer included in the dataset. Surrogate data is included in the report where indicated.

Geometric mean of children tested

The geometric mean is the correct statistical measure to indicate the average blood lead level of the children tested (see answer to next question for more information).

Number and geometric mean of children aged 24 months tested

Children's blood lead levels typically peak around their second birthday and then plateau (see Figure 1). At this age, levels are not likely to change very much. So test results from this age group are the most useful and robust measure to determine trends in blood lead levels for the whole population and for monitoring the effectiveness of exposure-reduction strategies.

Number of children with levels less than or equal to five micrograms per decilitre

The Australian National Health and Medical Research Council (NHMRC) updated its recommendation in May 2015 indicating that 'if a person has a blood lead level greater than five (5) micrograms per decilitre, the source of exposure should be investigated and reduced, particularly if the person is a child or pregnant women'.

https://www.nhmrc.gov.au/files/nhmrc/publications/attachments/eh58_nhmrc_statement_lead_effects_human_health_a.pdf (accessed August 2015).

Scientific evidence does not show effects on a person's health at blood lead levels below five micrograms per decilitre. This level is not intended to be used as a 'safe' level of exposure or a 'level of concern' but rather a level at which sources of lead exposure need to be investigated. When we refer to children's blood lead levels being high or elevated, this means levels above the NHMRC's recommended exposure investigation level. SA Health endorses the NHMRC statements and reports this measure.

Number of children with levels less than 10 micrograms per decilitre

The previous NHMRC recommendation was that sources of lead exposure should be investigated when blood lead levels were higher than 10 micrograms per decilitre. However, research now shows that blood lead levels below 10 micrograms per decilitre may be associated with some health effects in adults and children.

At levels between five and 10 micrograms per decilitre health effects have been observed at a population levels, but at this stage the NHMRC has concluded that at these levels the evidence is not strong enough to show whether these health effects were caused by exposure to lead or by other health and lifestyle factors.

At levels above 10 micrograms per decilitre, it is well-established that exposure to lead can have harmful health effects in both adults and children. SA Health reports this measure.

Percentage of children tested with levels less than or equal to five micrograms per decilitre or less than 10 micrograms per decilitre

This measure tells us what percentage of children tested meet the recently updated or previous national recommendations.

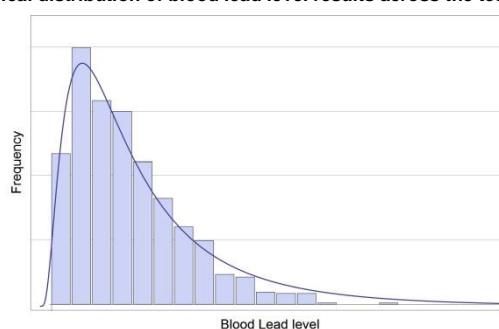
But this percentage does not represent all children aged less than five years living in Port Pirie because not all children are enrolled in the blood screening program and children are not tested in every reporting period. Only the annual report includes a test result for every enrolled child. To give an indication of what the actual proportion is, lower and upper limits are calculated using Port Pirie population projections from the 2011 census. The actual proportion of the population with blood lead levels either less than or equal to five micrograms per decilitre or below 10 micrograms per decilitre, falls somewhere between the lower and upper limits.

Why do we report the geometric mean?

The geometric mean indicates the 'typical' blood lead level of a child in Port Pirie. Monitoring geometric mean trends provides guidance about improvements in population blood lead levels over time, and the effectiveness of exposure-reduction strategies. But it cannot be used to guess the exact number of children above or below a blood lead level.

The geometric mean, rather than the average or arithmetic mean, is the correct way to summarise and report health-related data like blood test results. This is because of the nature of the distribution of results across the population. Most children have low levels, with only around 25 per cent having levels above 10 micrograms per decilitre. So there is not exactly the same number of children above and below the arithmetic average. Statisticians call it a normal distribution of data if there is the same number of data points above and below the arithmetic average (i.e. a bell-shaped curve). Blood results are not considered to be 'normally distributed' across a population (see Figure 2). This is the reason why we report the geometric mean of children's blood lead levels.

Figure 2: Typical distribution of blood lead level results across the tested population



Why do we use a child's most recent blood lead result in the report: does this 'play down' high blood lead levels?

SA Health uses the most recent blood lead result for each child to generate the report. Most children only have one blood test taken in each reporting period, but for those with more than one, using the most recent test result gives the most up-to-date and accurate picture of how the population as a whole is being impacted by lead from year to year. The purpose of monitoring these trends is to gauge the overall effectiveness of exposure-reduction strategies and make necessary adjustments or modifications to community strategies to respond to changing environmental conditions in a timely manner.

The population health measures we report provide us with the tools to effectively deliver SA Health's public health program in Port Pirie.

The population trends in our reports do not determine how we protect individual children, but rather they are used to look at how the overall population is being affected to inform higher level strategic approaches to the management and reduction of exposure to lead in the Port Pirie environment. The most important way to protect individual children is to use each test result to adjust individual strategies for families; responding rapidly to their unique exposure situations. The result of every test a child has is used by SA Health staff to develop the correct approach for individual situations.

Why don't we include every test result collected for each child in the report: does excluding multiple tests for some children from the dataset 'play down' the number of children at risk?

As discussed, most children have one test (taken around their birthday), but the small number of children who have high blood lead levels have more than one test taken in the reporting period. SA Health uses the most recent blood lead result recorded for each child to calculate the proportion of children with blood lead levels below five or 10 micrograms per decilitre at the time of reporting. To do this each child can only be represented once in the dataset for each reporting period.

Therefore, this is not a measure of the proportion of all test results recorded below this level; instead it is a measure of the proportion of children tested below this level.

This method enables us to make a valid comparison of trends from year to year – comparing matching datasets for the same reporting period each year i.e. comparing 'like with like'.

Including multiple test results for those children with the highest levels would introduce bias by over-representing children with high blood lead levels and prevent a statistically valid comparison of blood lead trends between years.

Why do we include mothers' blood lead results in the report: does this 'play down' the number of children at risk?

Mothers' blood lead results measured during pregnancy or immediately post-birth are used to represent newborns' lead exposure until each baby has its first test at six months of age (i.e. surrogate data). Once we have a test result for a baby, or it is more than nine months since the mother's test was taken, the mother's test result is no longer included in the dataset.

Peer-reviewed research shows that babies are born with virtually the same blood lead levels as their mothers. So the mother's test result taken close to the time of birth is included in the dataset rather than taking an unnecessary blood sample from newborn babies.

It is rare that a baby's blood lead level rises above five micrograms per decilitre prior to the first test at six months of age unless they are exposed to an extreme direct source of lead like lead paint or lead contaminated rain water.

As explained earlier, using mothers' blood lead results is the same as using the newborn babies' results. This enables us to monitor trends of children from birth.

Why don't we report the highest and lowest blood lead results measured?

SA Health does not report individual results like the highest and lowest test results for children because this does not accurately reflect current population trends. Reporting actual test results may allow individual families or children to be identified which breaches privacy laws and confidentiality. This may discourage parents from having follow-up tests.

Why do we compare the results of each reporting period from year-to-year but not between quarters?

SA Health compares the same reporting period each year to monitor trends in population blood lead levels over time. There are seasonal effects on lead exposure and the numbers of children tested that introduce statistical bias into comparisons made between quarters. For example, measures from a half year report cannot accurately be compared to an annual report. Seasonal factors, such as weather patterns, wind speeds and timing of dust-generating activities, are

corrected by comparing results from the same reporting period each year – i.e. comparing 'like with like'.

Comparing the annual report between years provides the most robust comparison. The annual dataset contains a test for every child enrolled in the program. The half yearly dataset only represent one half of the population respectively. So the annual report provides the most complete overview of the tested population.

Do these reports represent all children living in Port Pirie?

The sample size cannot be interpreted to represent the entire population because we don't have test results for each child in every report. The reasons for this are:

- > Although there is a high level of community participation in the blood screening program, as with any other medical screening program, participation is voluntary and parents have the right to choose not to have their child tested.
- > Not all enrolled children are tested by each report date. For example, for the half year report, only half of children enrolled in the program have been tested.
- > Some children are assessed to be at such a low risk of lead exposure and developing lead-related health effects that they do not need testing beyond three years of age as part of their management strategy. A child with a history of consistently low levels or at low risk of lead exposure do not require testing as part of their management strategy, particularly those children aged above two years. But children at high risk of lead exposure and elevated blood lead levels are encouraged to be regularly tested.

The reports are considered very reliable for reporting the proportion of the population with blood lead levels above 10 micrograms per decilitre – those children at most risk. But children with low blood lead levels are under-represented (for the reasons given above). There is no ethical way to correct this bias because testing cannot be mandated.

To help address this limitation, a statistical range (confidence intervals represented by upper and lower limits) of children equal to or below five or below 10 micrograms is provided to represent the proportion of children in each blood lead range. If every child was tested, the actual proportion of the population should fall within this range.

Upper and lower limits used for this range are calculated using the most recent estimate of the population of Port Pirie children aged zero to four years derived from the 2001, 2006 and 2011 ABS census data.

Why do the numbers of children sometimes vary when comparing reports from different years?

Ongoing routine audit of the blood-lead results database that occurs when each analysis is undertaken will continue to identify small numbers of data-entry anomalies that arise from database limitations, for example when families change residential addresses. Correction of these anomalies can result in a minor variation (usually an increase) in the number of children's and surrogate's test results included in a dataset when compared to the same dataset reported in corresponding reports prepared for the previous year. These variations are not considered to impact on reported geometric means and proportions (%). Upper and lower limits may also vary between reports as they are adjusted from year to year for the estimated population size based on ABS census data.

Are SA Health's reporting methods valid?

The methods used provide the most appropriate analysis of blood lead trends for the purposes of public health protection and maximising SA Health's program effectiveness.

SA Health has compiled and monitored blood lead results in Port Pirie for close to 30 years to gauge trends that help manage the impacts of lead on children in the community. Regular reports are published to enable public scrutiny of the public health program. The data is not designed to be used to monitor smelter performance, nor is it an academic exercise; it is an essential part of the lead abatement program. Claims of manipulation or misleading the public are detrimental because they can damage vital engagement and participation of the Port Pirie community in coordinated efforts to reduce lead exposure and give every child the best possible start in life.

Why did we change from using a child's maximum test result in the report to using the most recent test result?

In 2005, SA Health was asked by stakeholders to increase the frequency of its blood lead level reports. Significant and rapid improvements in blood lead levels and lead-in-air levels were starting to occur at this time. To make sure SA Health's lead abatement program was responsive to rapidly changing lead exposure, it was decided to use each child's most recent test in the dataset to enable the most up-to-date information about community lead impacts to be monitored.

Prior to 2005, each child's maximum test result was used – so it was possible that a test result included in the dataset was measured up to 12 months before the report was prepared. Using old test results prevents us from identifying rapidly emerging trends in population lead exposure and responding quickly and making the best use of resources available to us.

As discussed, most children have either increasing blood lead levels (those aged up to two years) or have plateaued (those older than two to three years). Therefore, for most children the most recent test is more likely to be higher than the child's previous test result (usually taken the year before - see Figure 1).

So it is appropriate to use the most recent result to monitor trends in blood lead levels.

Why has a line chart been used when data is not continuous?

A schematic illustration in the form of a dotted line chart has been used in the report to represent trends in the geometric means of all children tested and those aged 24 months. A line graph allows for easier visual depiction of yearly trends than a bar chart. However, it is not intended to infer that the data is continuous i.e. identical datasets (children) compared each year, as the tested population changes each year as children age and leave the program and new children are born.

For more information

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