Port Pirie Blood Lead Levels

Analysis of blood lead levels for 2023
(1 January – 31 December 2023)

Government of South Australia
SA Health

Background

Situated 230 km north of Adelaide in South Australia, Port Pirie is the location of one of the world's largest lead and multi metal smelters.

The smelter has been in continuous operation since 1889. Over time, airborne lead-contaminated dust produced during smelter operations has contaminated the local environment. Even small amounts of lead can be toxic when ingested or inhaled. Notwithstanding ongoing improvements to practices that reduce dust, lead dust emissions from the smelter, together with legacy lead from past operations, continue to be persistent sources of exposure for the Port Pirie community.

SA Health has provided voluntary blood lead screening through the Port Pirie Lead Implementation Program that has been delivered by the Port Pirie Environmental Health Centre since 1984. This Program monitors and helps the local community reduce the amount of lead that children absorb by providing lead exposure-reduction advice, education and interventions for families. This paper reports the analysis of blood lead levels of Port Pirie children under 5 years of age (0-1824 days of age i.e. up to the date of a child's fifth birthday) and pregnant women that have been tested each year since 2013. Reports summarising data from the blood testing program for years before 2013 are available on request.

Australian lead guidelines

The National Health and Medical Research Council (NHMRC) provides health advice and guidelines for the Australian community, governments and health professionals. One of the NHMRC's tasks is to advise the Australian community about lead exposure and the health effects of lead and how they can be managed.

Guideline for investigating lead exposure

The NHMRC recommends that if a person has a blood lead level greater than 5 micrograms per decilitre (µg/dL), the source of lead exposure should be investigated and reduced, particularly if the person is a child or pregnant woman. See the Frequently Asked Questions: NHMRC Review of blood lead level guidelines.

The NHMRC advises it is well established that exposure to lead at blood lead levels above 10 µg/dL can have harmful effects on body functions and organs in both adults and children. Research now shows that blood lead levels below 10 µg/dL may also be associated with some health effects (NHMRC 2015, Evidence on the effects of lead on human health). At this stage, the NHMRC has concluded that the evidence is not strong enough to show that lead is the cause of these effects.

In line with NHMRC's guidance, the blood lead levels of children living in Port Pirie are reported against the exposure investigation level of 5 µg/dL. This is in addition to the target level of 10 µg/dL that has been reported each year since 2000 and was the target level of the Targeted Lead Abatement Program when it commenced in 2014.

Blood lead levels of Port Pirie children under 5 years of age

Blood lead levels above 5 micrograms per decilitre

In 2023, 372 children had a reported result above the NHMRC blood lead exposure investigation level of 5 µg/dL (Table 1 and Figure 1).

Blood test results indicate that 66.3% of the children tested in 2023 had blood lead levels above 5 µg/dL. This is a 1.6% increase compared to 2022.

These percentages cannot be reported or interpreted to represent the proportion of the Port Pirie population above 5 µg/dL because not every child living in Port Pirie was tested in 2023, therefore their blood results do not appear in this analysis. It can be said with a high degree of confidence (95%) that the proportion of the entire population with blood lead levels above 5 µg/dL would fall between the lower limit of 64.2% and the upper limit of 68.4% (the 95% confidence interval) if every child under 5 years of age living in Port Pirie was tested (Table 1 and Figure 1). Population estimates used to calculate these limits are based on Estimated Resident Population (ERP) data for Port Pirie provided by the Australian Bureau of Statistics (ABS).

The 95% confidence intervals that contain the population proportions may vary between reports because they are adjusted from year to year for the estimated population size. Figure 1

Table 1: Percentage of children under 5 years of age (0-4yrs) tested with blood lead levels above the Lead Exposure Investigation Level >5 µg/dL and the lower limit and upper limit (95% confidence interval) for each calendar year 2014-2023.

Year	ERP estimated number of children under 5 years of age	Total number of children tested	>5 µg/dL			
			n	Lower limit	%	Upper limit
2014	809	560	284	48.4	50.7	53.0
2015	773	556	264	45.3	47.5	49.7
2016	786	571	279	46.7	48.9	51.0
2017	773	550	288	50.1	52.4	54.6
2018	773	515	296	55.0	57.5	59.9
2019	758	564	359	61.6	63.7	65.6
2020	772	553	377	66.1	68.2	70.2
2021	782	597	385	62.6	64.5	66.4
2022	774	549	355	62.5	64.7	66.8
2023	**780**	**561**	**372**	**64.2**	**66.3**	**68.4**

Blood lead levels measured at the time of children's second birthdays (2-year-old children) are considered to be robust indicators of lead exposure for the whole population. This is also the age of children who have the highest level of participation in the blood testing program so results for this age group give the best representation of trend.

In 2023, 68 children tested at their second birthday had a reported result above the NHMRC blood lead investigation level of 5 µg/dL (Table 2 and Figure 1).

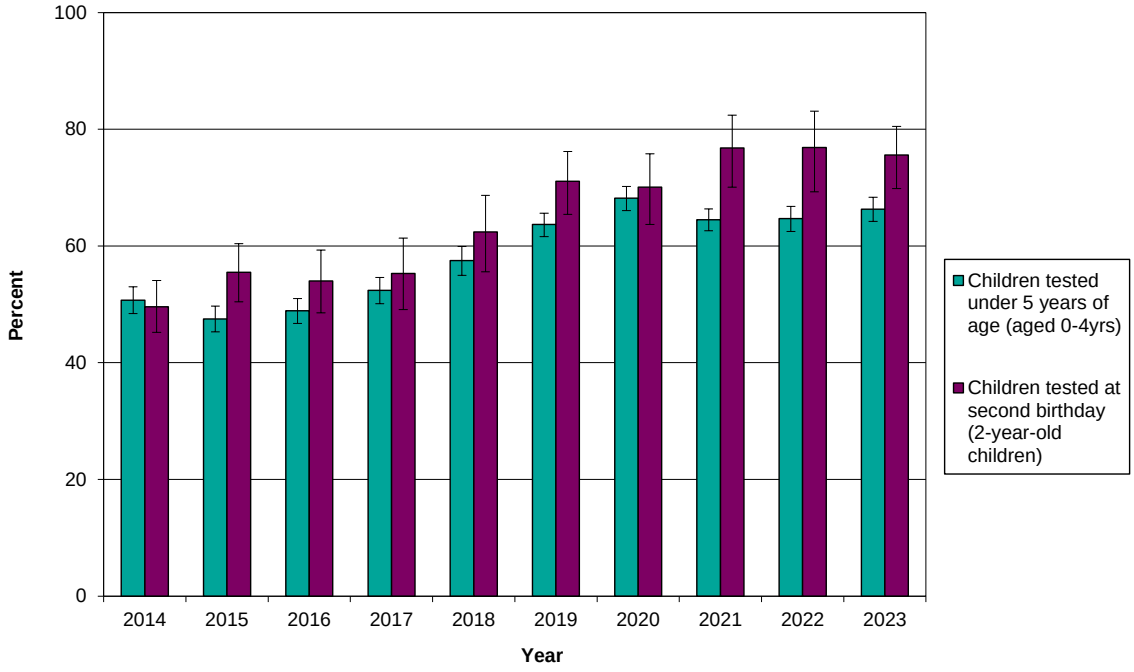
Blood test results indicate that 75.6% of children tested at their second birthday in 2023 had blood lead levels above 5 µg/dL. This is a 1.3% decrease compared to 2022.

Table 2: Percentage of children tested at their second birthday (2-year-old children) with blood lead levels above the Lead Exposure Investigation Level >5 µg/dL and the lower limit and upper limit (95% confidence interval) for each calendar year 2014-2023.

Year	ERP estimated number of children at their second birthday	Total number of 2-year old children tested	>5 µg/dL			
			n	Lower limit	%	Upper limit
2014	186	135	67	45.2	49.6	54.1
2015	172	119	66	50.4	55.5	60.4
2016	171	113	61	48.5	54.0	59.3
2017	148	94	52	49.1	55.3	61.4
2018	165	93	58	55.6	62.4	68.7
2019	133	90	64	65.4	71.1	76.2
2020	171	97	68	63.7	70.1	75.8
2021	147	82	63	70.1	76.8	82.4
2022	166	78	60	69.3	76.9	83.1
2023	**139**	**90**	**68**	**69.8**	**75.6**	**80.5**

CAVEAT: there is no accurate ABS estimate for the number of children who turned 2 years of age in each calendar year, therefore an estimate has been extrapolated from ABS birth data for Port Pirie in 2 years prior to the reporting year to derive the lower and upper limits for this age group.

Figure 1: Percentage of tested children with blood lead levels >5 µg/dL for children under 5 years of age (0-4yrs) and children at their second birthday (2-year-old children) for each calendar year 2014-2023. Bars indicate the lower limit and upper limit of the 95% confidence interval.



Results in each category of blood lead level

Blood test results indicate that 39% of children tested in 2023 had blood lead levels between 5 µg/dL and 10 µg/dL, 16.8% between 10 µg/dL and 15 µg/dL and 7.3% between 15 µg/dL and 20 µg/dL (Table 3 and Figure 2).

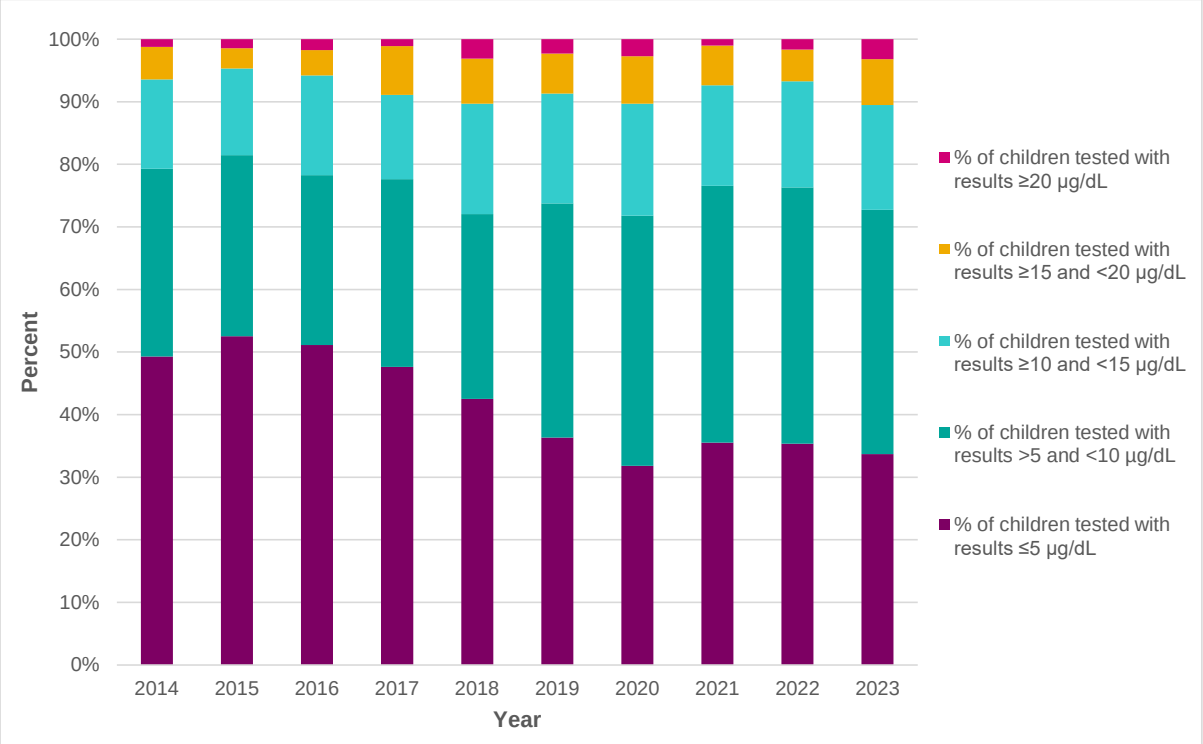
The number of children with blood lead levels equal to or exceeding 20 µg/dL (18 children) has increased compared to the number reported for 2022 (9* children).

Table 3: Percentage of children under 5 years of age (0-4yrs) tested in each blood lead level category for each calendar year 2014-2023.

Year	Number and percentage	Children ≤5 µg/dL	Children >5 and <10 µg/dL	Children ≥10 and <15 µg/dL	Children ≥15 and <20 µg/dL	Children ≥20 µg/dL	Total number of children tested
2014	n	276	168	80	29	7	560
	%	49.3%	30.0%	14.3%	5.2%	1.3%	
2015	n	292	161	77	18	8	556
	%	52.5%	29.0%	13.8%	3.2%	1.4%	
2016	n	292	155	91	23	10	571
	%	51.1%	27.1%	15.9%	4.0%	1.8%	
2017	n	262	165	74	43	6	550
	%	47.6%	30.0%	13.5%	7.8%	1.1%	
2018	n	219	152	91	37	16	515
	%	42.5%	29.5%	17.7%	7.2%	3.1%	
2019	n	205	211	99	36	13	564
	%	36.3%	37.4%	17.6%	6.4%	2.3%	
2020	n	176	221	99	42	15 (16)	553
	%	31.8%	40.0%	17.9%	7.6%	2.7%	
2021	n	212	245	96	38	6	597
	%	35.5%	41.0%	16.1%	6.4%	1.0%	
2022	n	194	225	93	28	9 (8)*	549
	%	35.3%	41.0%	16.9%	5.1%	1.6%	
2023	**n**	**189**	**219**	**94**	**41**	**18**	**561**
	%	**33.7%**	**39.0%**	**16.8%**	**7.3%**	**3.2%**	

**8 children were reported in the 2022 annual report to have blood lead levels equal to or exceeding 20 µg/dL. However, a routine audit identified a subsequent confirmatory test of one of these children returned after finalising the report with a level above 20 µg/dL which means that overall, 9 children had blood lead levels equal to or exceeding 20 µg/dL measured in 2022.*

Figure 2: Percentage of children under 5 years of age (0-4yrs) tested in each blood lead level category for each calendar year 2014-2023



Blood lead levels equal to or above 10 micrograms per decilitre

Blood tests indicate that 27.3% of children tested had blood lead levels equal to or above 10 µg/dL. This is a 3.6% increase compared to 2022 (Table 4).

Table 4: Percentage of children aged under 5 years of age (0-4 yrs) tested with blood lead levels ≥10 µg/dL and the lower limit and upper limit (95% confidence interval) for each calendar year 2014-2023.

Year	ERP estimated number of children under 5 years of age	Total number of children tested	≥10 µg/dL			
			n	Lower limit	%	Upper limit
2014	809	560	116	18.9	20.7	22.6
2015	773	556	103	16.9	18.5	20.3
2016	786	571	124	20.0	21.7	23.5
2017	773	550	123	20.5	22.4	24.3
2018	773	515	144	25.8	28.0	30.3
2019	758	564	148	24.4	26.2	28.1
2020	772	553	156	26.2	28.2	30.3
2021	782	597	140	21.8	23.5	25.2
2022	774	549	130	21.8	23.7	25.7
2023	**780**	**561**	**153**	**25.4**	**27.3**	**29.3**

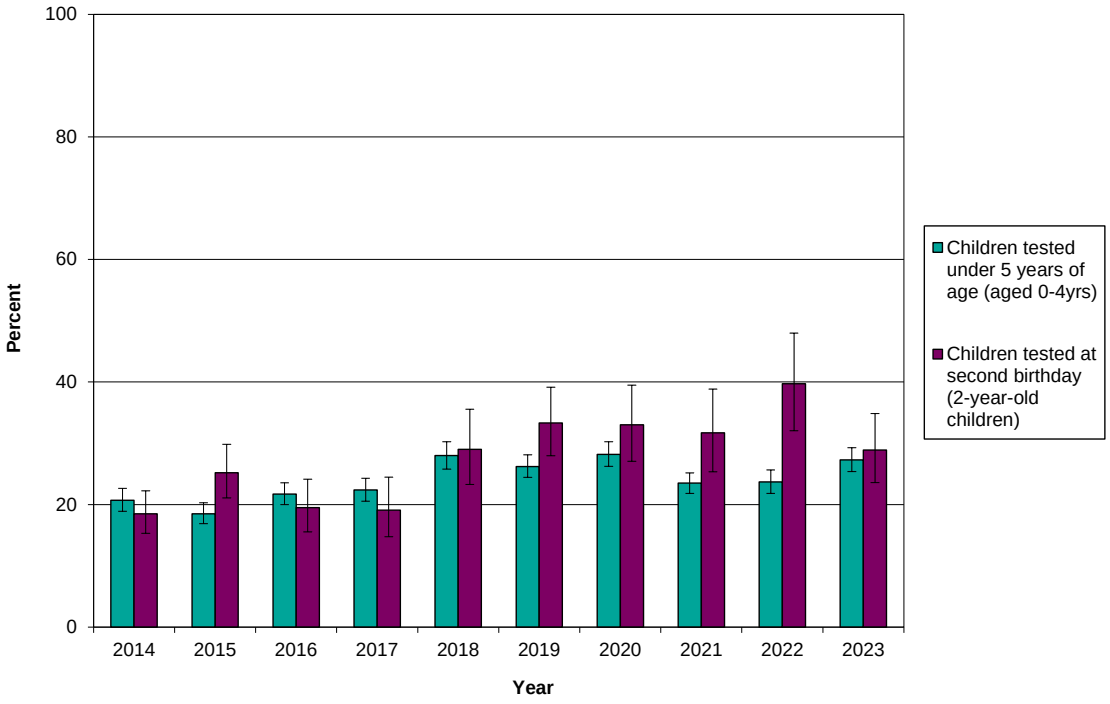
Blood tests indicate that 28.9% of children tested at their second birthdays had blood lead levels equal to or above 10 µg/dL. This is a 10.8% decrease compared to 2022 (Table 5).

Table 5: Percentage of children tested at their second birthday (2-year-old children) with blood lead levels ≥10 µg/dL and the lower limit and upper limit (95% confidence interval) for each calendar year 2014-2023.

Year	ERP estimated number of children at their second birthday	Total number of 2-year old children tested	≥10 µg/dL			
			n	Lower limit	%	Upper limit
2014	186	135	25	15.3	18.5	22.2
2015	172	119	30	21.1	25.2	29.8
2016	171	113	22	15.5	19.5	24.1
2017	148	94	18	14.7	19.1	24.5
2018	165	93	27	23.3	29.0	35.6
2019	133	90	30	28.0	33.3	39.2
2020	171	97	32	27.1	33.0	39.5
2021	147	82	26	25.3	31.7	38.9
2022	166	78	31	32.0	39.7	48.0
2023	**139**	**90**	**26**	**23.6**	**28.9**	**34.8**

CAVEAT: there is no accurate ABS estimate for the number of children who turned 2 years of age in each calendar year, therefore an estimate has been extrapolated from ABS birth data for Port Pirie in 2 years prior to the reporting year to derive the lower and upper limits for this age group.

Figure 3: Percentage of tested children with blood lead levels ≥10 µg/dL for children under 5 years of age (0-4yrs) and children at their second birthday (2-year-old children) for each calendar year 2014-2023. Bars indicate the lower limit and upper limit of the 95% confidence interval.



Average blood lead level for children tested on their second birthday

Blood tests indicate that the average blood lead level (geometric mean) of children tested on their second birthday (2-year-old children) in 2023 was 7.4 µg/dL (Table 6). This average has decreased by 0.4 µg/dL compared to 2022.

Table 6: Geometric mean blood lead levels for children tested on their second birthday (2-year-old children) for each calendar year 2014-2023.

Year	Number of 2-year-old children tested	Geometric mean of 2-year old children tested (µg/dL)
2014	135	5.5
2015	119	5.9
2016	113	5.5
2017	94	5.6
2018	93	5.8
2019	90	7.2
2020	97	7.3
2021	82	7.4
2022	78	7.8
2023	**90**	**7.4**

Blood lead levels of pregnant women living in Port Pirie

Blood tests indicate that the average blood lead level (geometric mean) of pregnant women living in Port Pirie who were tested in 2023 was 1.6 µg/dL (Table 7). This average has increased by 0.1 µg/dL compared to 2022. This measure represents the blood lead level that a child has at birth.

Table 7: Geometric mean blood lead levels for pregnant women tested (during pregnancy or immediately postpartum) for each calendar year 2014-2023.

Year	Number of pregnant women tested	Geometric mean of pregnant women tested (µg/dL)
2014	174	1.4
2015	196	1.5
2016	183	1.3
2017	143	1.4
2018	181	1.4
2019	158	1.8
2020	173	1.7
2021	170	1.4
2022	166	1.5
2023	**191**	**1.6**

Population profile

Population estimates indicate a decreasing number of children under 5 years of age living in Port Pirie (Table 8). Figure 4 represents this slight downward trend over the past 10 years from the ERP provided by the ABS that has been derived from census data. Revisions to ERPs for 2017-2022 were released by ABS in 2023 and supersede all previous estimates. This report uses a population estimate for 2023 that is a linear extrapolation from the ERP of children under 5 years of age (0-4 years) living in Port Pirie (SA2 location 405031122) over the past 5 years.

The ERP is updated by the ABS between censuses and completely revised each time a census is conducted. The ERPs used in this analysis are based on data for Port Pirie updated by the ABS on 28 September 2023 using migration and birth rates in addition to 2011, 2016 and 2021 census data. In 2022, the ABS revised their previously estimated ERPs for 2017-2021 based on the results of the 2021 census where a net undercount rate in South Australia was identified compared to the 2016 census (Post Enumeration Survey). Rebased ERP estimates for this period were substantially higher overall. Various methods to estimate the number of children under 5 years of age (0-4 years) living in Port Pirie have been assessed and a shorter period for extrapolation using the ERP data (i.e. base period of 5 years rather than 10 years) was found to be a more sensitive and appropriate approach to adapt to the changing dynamics of this population group. Therefore, five years of ERP data has been used to estimate the population from the 2022 report onwards, rather than a linear extrapolation using 10 years of ERP data as used in previous reports.

The ERP is the most reliable estimate of the population between census years because it accounts for changes in population such as births, deaths, and the movement of residents in and out of the region in addition to the most recent census data. While the ABS states that the ERP is the most accurate estimate of the population, there is inherent inaccuracy involved in estimating population, with the largest margin of error recorded with small population sizes such as the population of children under 5 years of age living in Port Pirie. Any minor change in determinants of population size such as migration and birth rate can cause a substantial change in population estimates as a result of the small population size.

Although there is no accurate ABS estimate for the number of children who turned 2 years of age (have their second birthday) in each calendar year, an estimate has been extrapolated from ABS birth data for Port Pirie in 2 years prior to the reporting year to derive the lower and upper limits for this age group in this report. ABS birth data for Port Pirie has not been impacted by the rebased ABS ERP estimates explained above.

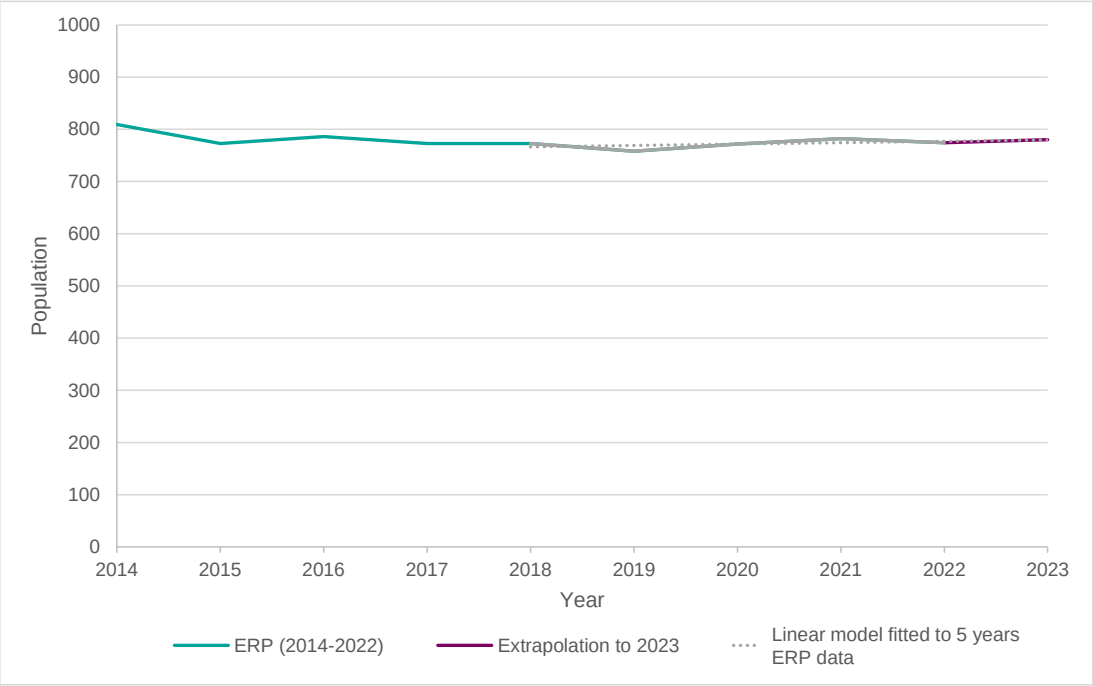
Table 8: ERP data provided by ABS for children under 5 years of age living in Port Pirie Statistical Area Level 2 (SA2) for each calendar year 2014-2022 and a linear extrapolated population estimate for 2023.

Age	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Estimated number of children under 5 years of age*	809	773	786	773	773	758	772	782	774	780
Estimated number of children at their second birthday‡	186	172	171	148	165	133	171	147	166	139

**Population estimates for children under 5 years of age living in Port Pirie SA2 (location code 405031122) each calendar year 2014-2023 are taken directly from ABS ERP data, except for 2023 which is a population estimate extrapolated from a linear model fitted to ERP data from the previous 5 years.*

‡Population estimates for children at their second birthday are made directly from ABS births data for Port Pirie SA2 in the calendar year 2 years prior – e.g. number of children who turned 2 years of age in 2023 = number of births in 2021.

Figure 4: ERP data provided by ABS for children under 5 years of age living in Port Pirie Statistical Area Level 2 (SA2) for each calendar year 2014-2022 and extrapolated population estimate for 2023.



Source: Australian Bureau of Statistics Estimated Resident Population 2013-2021 for Port Pirie (SA2 location code 405031122).

Analysis methods

Considerations when comparing current results with historical data and reports

Multiple methods of analysis and reporting that have been undertaken since the Port Pirie lead program commenced in the 1980s that impact on comparison of blood lead trends over the 10-year period reported here, or comparison of these results to historical reports. Consideration should be given to the following:

- Blood testing service providers for the Port Pirie community blood lead screening program changed on 1 January 2019, allowing for more advanced analytical methods to be utilised. This change should be considered when comparing data from 2019 onwards to previous years.
- From 2007 to June 2021, results were reported with surrogates where surrogate data (the mother's blood lead levels) was used to represent a child's blood lead level at birth and was included until either the child's first test at 6 months of age replaced it or it was removed if the child did not have any test by 9 months of age. From July 2021, results are reported separately either from pregnant women tested or from children under 5 years of age (0-4 years) with their first test usually at 6 months of age tested in the reporting period. Reports from July 2021 onwards should not be compared with reports from previous years containing surrogates.
- Routine data audits occur when each analysis is undertaken and will continue to identify small numbers of data collection and entry anomalies (e.g. clients reporting incorrect family details). Correction of these anomalies can result in a minor variation in the number of test results included in the dataset compared to reports prepared in previous years. However, this correction does not have significant impact on reported measures.

Blood lead data profile

Children included in this report were under 5 years of age (0-1824 days of age which is the time up to the date of a child's fifth birthday) and lived in Port Pirie at the time the blood test was taken. This is their age at the time the test was taken, not their current age. If more than one blood test was taken for a child in the reporting period, the child's most recent test result was used in this analysis. So, this analysis can include a child's test result that may have been collected any time up to 364 days prior to the preparation of this report. For this reason, a child's most recent test result may not represent the child's current blood lead level.

All blood samples included in this report are analysed by Australian laboratories accredited for blood lead analysis by the National Association of Testing Authorities (NATA Australia).

Sampling bias in blood lead data

These results cannot be interpreted to represent the entire population as test results for every child living in Port Pirie are not in every report because:

- Although there is a high level of community participation in the blood lead screening program, the program is voluntary and therefore parents have the right to choose not to have their child tested. For this reason, there is no ethical way to mandate testing for every child.
- Some children have a history of consistently low blood lead levels and have been assessed to remain at a low risk of lead exposure and developing lead-related health effects. These children will not benefit from ongoing testing beyond 3 years of age as part of their lead exposure management strategy. However, children at high risk of lead exposure are always encouraged to be regularly tested.
- Results pending re-test for confirmation are not included in this dataset but will appear in the next report.

These reports are considered very reliable for reporting the proportion of the population with blood lead levels above 10 micrograms per decilitre (the children at highest risk). However, children with low blood lead levels are under-represented i.e. there is inherent bias in this analysis (for the reasons given above). To help address some of this sampling bias, a statistical range is reported (the 95% confidence interval). It can be said with a high degree of confidence (95%), that the proportion of the entire population with blood lead levels above 5 µg/dL or equal to or above 10 µg/dL would fall between the lower limit and the upper limit (the 95% confidence interval) of this range if every child under 5 years of age living in Port Pirie was tested.

Further information about the analysis methods used in this paper is available at Frequently Asked Questions Testing and Reporting Port Pirie Children's blood lead levels.

This report prepared by: Scientific Services Branch, Health Protection and Regulation

February 2024

Doc. no. A5463650

File no. 2023-01055

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Public-I1-A1

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