Lead Program Annual Report 2022:

Broken Hill children less than 5 years old

Acknowledgements

We acknowledge the traditional owners of country throughout the region. We pay respects to the people and their culture and to Elders past and present.

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Executive Summary

Background

Broken Hill is a town established around the mining of the world's largest deposit of lead, silver, and zinc, known as the 'Line of Lode'. The Line of Lode has been mined continuously for almost 140 years resulting in ubiquitous lead in soil and dust throughout the town and surrounding areas. Lead is a naturally occurring element that can be harmful to the human body. It is well established that blood lead levels (BLLs) greater than 10 micrograms per decilitre (µg/dL) can have harmful effects on many organs and bodily functions. There is less conclusive evidence that BLLs ranging from 5 µg/dL to less than 10 µg/dL may be associated with adverse cognition and behaviour amongst other poor health outcomes. In New South Wales (NSW), BLLs 5 µg/dL and over are required to be notified to public health units and managed in accordance with the Lead in Blood Control Guidelines. For the purposes of this document 'guideline' refers to BLLs less than 5 µg/dL. Children aged under 5 years of age are more likely to breathe in or ingest small amounts of lead-contaminated dirt or dust as they interact with their physical environment. Children can absorb a higher proportion of lead than adults as their smaller bodies rapidly grow and develop and are therefore more at risk to the harmful effects of long-term lead exposure.

Broken Hill Lead Program

The Broken Hill Lead Program (The Program) aims to undertake annual BLL screening of all resident children aged under 5 years and to manage and treat in accordance with the *Lead in Blood Control Guidelines*, those children found to have BLLs above the guideline. Blood lead testing is voluntary and offered free of charge to parents and carers through the Broken Hill Child and Family Health Service and the Maari Ma Primary Health Care Service. Children are screened every 6 months till the age of 2 years, at 3 years and then at 4 years. Screening of umbilical cord BLLs of newborns, born to Broken Hill resident mothers is also included in the Program.

The Program is intended to monitor children's BLLs as they interact with their physical environment across three developmental stages, from being completely dependent to being physically independent. The *Lead Program Annual Report 2022* presents an update on trends in BLLs over time following the 2022 screening of children according to these three stages of development: newborns, 6 months to less than 12 months of age and 1 year to less than 5 years of age. As a child may undergo multiple blood lead tests in the same year, the first BLL is used for analyses for each of the three categories.

The *Lead Program Annual Report 2022* presents trends in BLL screening for newborns and children aged 1 year to less than 5 years from 2013; and, for babies aged from 6 months to less than 12 months from 2018, due to there being no testing for this age group during the years 2013 to 2017. Reports summarising data from the commencement of the Program in 1991 are available on request.

Results

Newborns, 2013 to 2022

In 2022, umbilical cord blood from 157 newborns of Broken Hill resident mothers were tested for BLLs. Of these newborns, 22% (n=34) are Aboriginal and 78% (n=123) are non-Aboriginal. Of the 157 umbilical cord bloods screened:

- All had BLLs within the guideline (less than 5 µg/dL).

- The geometric mean (geomean) of all BLLs was 0.6 µg/dL.

Further, there was very little difference between the geomean of BLLs for Aboriginal newborns compared to that for non-Aboriginal newborns i.e., 0.7 µg/dL and 0.6 µg/dL, respectively.

Over the 10 years from 2013 to 2022, the number of newborns screened for BLLs fell slightly (5%), i.e., from 166 to 157, respectively. Due to a change in the recording of BLLs from 2016 onwards, comparisons to annual geomeans prior to 2016 is not possible. As such, over the 7 years from 2016 to 2022, the annual geometric mean (geomean) has declined from 0.8 µg/dL to 0.6 µg/dL, respectively.

Children aged 6 months to less than 12 months, 2018 to 2022

In 2022, there were 208 children screened aged from 6 months to less than 12 months. Of these children:

- 14% (n=29) had BLLS above the guideline, which is more than that in 2021 (7%) but equal to the 3-year average for the years 2018 to 2020. NB: screening numbers for 2022 were 30% more than those in 2021 (160 and 208, respectively).
- 19% (n=40) are Aboriginal and 80% (n=166) are non-Aboriginal, with a small number having no record for this indicator (n=2).
- 33% (n=13) of Aboriginal children had BLLS above the guideline compared to 10% of non-Aboriginal children (n=16).
- The geomean of all BLLs was 2.5 µg/dL.
- The geomean for Aboriginal children while within the guideline was 1.0 higher µg/dL than that for non-Aboriginal children i.e., 3.3 µg/dL and 2.3 µg/dL, respectively.

Over the five years from 2018 to 2022, the number of screened children aged 6 months to less than 12 months increased by 33% (156 to 208, respectively). At the same time, there were small decreases in the annual geomeans (2.7 µg/dL to 2.5 µg/dL, respectively) and the per cent of children with blood lead levels above the guideline (15% to 14%, respectively).

Children aged 1 year to less than 5 years, 2013 to 2022

In 2022, there were 619 children aged 1 year to 5 years screened for BLLs. Of these children:

- 21% (n=127) are Aboriginal and 79% (n=489) are non-Aboriginal, with a small number (n=3) where there was no record for this indicator.
- Using the ABS 2021 Census population count for Broken Hill resident children aged 1 to less than 5 years as the denominator, the estimated participation rate in the Program for all children was 79% while that for Aboriginal children was 89%.
- While the participation rate for Aboriginal children appeared high, the number of Aboriginal children screened was the lowest for the 10-year reporting period (n=127).
- Two-thirds of Aboriginal children screened (66%) had BLLs above the guideline.
- 8% of Aboriginal children screened had high or very high BLLs (20 µg/dL or higher) compared to less than 1% of non-Aboriginal children.

Applying the age-sex standardised calculations to the Broken Hill ABS population for children aged 1 year to less than 5 years, the annual geomean was 4.1 µg/dL, which is within the guideline.

Nevertheless, there were an estimated 306 (39%) Broken Hill children with blood lead levels above the guideline in 2022.

Over the 10-year period from 2013 to 2022, the number of screened children aged 1 year to less than 5 years fell by 11% (695 to 619, respectively). This declining trend aligns with a 12% decrease in the ABS Census Broken Hill population count in this age group from 2011 to 2021. Comparing the estimated participation rate for 2013 to that in 2022, there was little change i.e., 78% and 79%, respectively. However, variation in participation rates over the 10-year period is evident with an average annual estimated participation rate of 83%. As such the 2022 rate of 79% is less than the reporting period average but an improvement from that in 2021 (72%).

From 2013 to 2022, the annual age-sex standardised BLL geomean for all children in this age group fell by 1.6 µg/dL i.e., from 5.6 µg/dL (above the guideline) to 4.1 µg/dL (within the guideline), respectively and the per cent of children with blood lead levels above the guideline decreased from 53% to 39%. Similarly, the annual age-sex standardised BLL geomean for Aboriginal children has fallen by 1.1 µg/dL over the 10-year reporting period but remains above the guideline, i.e., from 8.2 µg/dL to 7.1 µg/dL, respectively. The per cent of Aboriginal children with blood lead levels above the guideline decreased from 77% to 66%, respectively.

For the 10-year reporting period, the average annual per cent of screened Aboriginal children in this age group with BLLS within the guideline is almost half that for non-Aboriginal children, i.e., 27% compared to 51%.

Seasonal trends, 2022

In 2022 there were no clear seasonal trends in monthly or quarterly geomeans associated with screening numbers, temperatures, or rainfall.

Conclusion

Over the reporting periods, improvements in annual geomeans, i.e., decreases towards or below the guideline, are evident with reductions seen across the three developmental groups for all children as well as for Aboriginal children. While overall, the rates of children aged 6 months to less than 12 months with BLLs above the guideline remain largely unchanged, improvements are noted for children aged 1 year to less than 5 years. Importantly however, Aboriginal children have consistently higher average annual geomeans and greater rates of BLLs above the guideline than non-Aboriginal children. Further, there is a decreasing trend in the number of Aboriginal children aged 1 year to less than 5 years participating in the Program in 2022.

Background

Broken Hill is a town located in the far west of New South Wales (NSW) that was founded in 1883 following the discovery of the world's largest deposit of lead-silver-zinc. The ore body known as the 'Line-of-Lode', has been mined continuously since 1884[1] with the city growing around the Line-of-Lode. Broken Hill experiences a hot, dry, and windy climate. Onsite smelting activities and waste management practices in the early years of mining and the impact of wind and water erosion on lead-contaminated sites has resulted in the ubiquitous distribution and concentration of lead in soil and dust throughout the city. Consequently, Broken Hill residents, miners, industry workers and their families experience long term environmental lead exposure. While changes to mining practices including underground extraction, off-site smelting, capping of waste dumps along the Line of Lode, storm water control on the mining leases and waste disposal regulation have seen a large reduction in atmospheric lead emissions, the ore continues to be brought to the surface for processing and concentration.[2,3] Further, predicted climate changes for Far West NSW that will see temperatures increase and rainfall decrease over the 20 years from 2020 to 2039[4] are likely to increase the frequency of dust storms, soil dispersion and therefore elevate lead dust loading into the environment.

The effect of lead exposure on health varies according to age, dose, and length of exposure. The ill-health risk for children and babies (including in utero) exposed to lead is higher than in adults, because their bodies are smaller, and their bodies and brains are growing and developing at a rapid rate.[5] Children are more likely to breathe in or ingest lead-contaminated dust and dirt as they explore and physically interact with their environment and frequently touch their mouths. Lead toxicity affects a range of molecular processes, partly due to its ability to inhibit and mimic the actions of calcium. This in turn effects many organs and systems within the body.

Lead is a naturally occurring element found in a variety of compounds and remains in the earth until physically removed through mining. As a result of long-term mining and widespread industry use including house paint and petroleum, lead can be found throughout the Australian environment.[5] People absorb lead into the body by ingesting or breathing in lead-contaminated dust. As such, most people have some level of lead in their system. The average 'background' blood lead level (BLL) is estimated to be less than 5 micrograms per decilitre (µg/dL).[5]

There is an association between BLLs of 5 to 10 µg/dL and adverse cognitive effects and behavioural problems in children, a delay in sexual maturation in adolescents and increased blood pressure in adults. For BLLs greater than 10 µg/dL there is well established adverse effects on digestive, cardiovascular, renal, reproductive, and neurological functions.[6] Currently, BLLs equal to or above 5 µg/dL are notifiable under the 2016 Public Health Amendment to the NSW Public Health Act 2010. For the purposes of this report, 'guideline' will refer to BLLs less than 5 µg/dL.

Broken Hill Lead Program

A 1991 survey of Broken Hill children aged from 1 year to less than 5 years of age found that 86% of these children had BLLs of 10µg/dL or above and that 38% had very high lead levels of 20µg/dL or above. Following these findings, a targeted program designed to monitor BLLs in children aged under 5 years of age, commenced in Broken Hill. Between 1991 and 2012, the age-sex standardized geometric mean blood lead level reduced by about two-thirds (from 16.7 µg/dL to 4.5 µg/dL) and has since ranged between 4.5 – 5.9 µg/dL in most years.[7]

The Program has evolved over time to collect blood lead samples from three groups of children

aged less than 5 years. The three groups are based on the developmental progression of children from being completely dependent to being physically independent, and include:

1. Newborns, whose umbilical cord blood is tested at birth to determine the impact of lead transfer from the mother to the child and is considered a proxy baseline for the child.
2. Children aged 6 months to less than 12 months, who are learning to explore their environment by putting objects into their mouths and have limited mobility through crawling but may be restrained outside.
3. Children aged between 1 year and less than 5 years, who are generally able to move freely to interact with their environment.

Comparisons of BLLs across the groups inform both intervention needs and monitoring of the Program. Program participation is free of charge and voluntary, and screening is aligned with the immunisation schedule so that children are tested at 6 months, 12 months, 18 months, and 2 years and then at 3 years and again at 4 years. The Program is promoted via reminder phone text messaging to parents and carers, promotions and advertising through local media. If BLLs are found to be above the guideline, children are recalled for repeat testing, management and treatment as per the NSW Health's Lead in Blood Control Guidelines.

Broken Hill Local Government Area Population Profile

Each Census conducted by the Australian Bureau of Statistics (ABS) since lead monitoring commenced (1996, 2001, 2006, 2011 and 2016) has seen a decreasing trend in both the number and the proportion of children under the age of 5 years residing in the Broken Hill Local Government Area (Table 1). Analysis conducted for the annual lead report is stratified by Aboriginality to monitor any inequitable burden of high BLLs which may exist. Counts of the Aboriginal children population are sourced from the Census and are reliant on self-identification. The number of Aboriginal children aged under 5 years has increased by 71% from 1996 to 2021, conversely, over the same period, the number of all Broken Hill children aged under 5 years has decreased by 31%.

Table 1: ABS Usual Resident Population 0-4 years from 1996 to 2021, total population and Aboriginal children, 1996 to 2021

Census Year	1996	2001	2006	2011	2016	2021	1996-2021 % change
All children 0-4 years (% of total population)	1,403 (6.6%)	1,297 (6.4%)	1,191 (6.1%)	1.070 (5.8%)	974 (5.5%)	972 (5.5%)	-31%
Aboriginal children 0-4 years (% of all 0-4 population)	112 (8%)	165 (13%)	177 (17%)	176 (16%)	182 (19%)	191 (20%)	71%

Source: Australian Bureau of Statistics, Usual Resident Population, Census and Housing.

Methods

Collection of blood samples

For newborn babies born through normal vaginal delivery, umbilical cord bloods are laboratory tested in the same way as a venous sample. BLLs for children less than 5 years are taken as either a finger prick (capillary) or venous test (considered more invasive). With lead screening aligned to the childhood immunisation schedule, testing may occur at 6 months, 12 months, 18 months, 2 years, and 4 years of age. Children aged 3 years of age are encouraged to be tested to ensure each child is tested at least once every year till they turn 5 years old.

Data collation and analysis of blood lead levels

Where a child has had multiple BLL tests in the same calendar year, only the first test for the year is used for analysis. Exceptions include where a child is tested and aged from 6 months to less than 12 months turns 1 in the same year; they will be included in the analysis twice i.e., in the 6 months to less than 12 months group and then in the 1 year to less than 5-year age group. Where a venous test and capillary test have been collected in the same calendar year for a child, the venous test, considered a more accurate test, is included in the analysis over the capillary test.

The geometric mean (geomean), as opposed to an average or arithmetic mean, is used to report BLLs. This is because the majority of children have lower BLLs with a smaller number having very high levels. The arithmetic mean is strongly affected by the very high values whereas the geomean normalises the values being averaged so that no value dominates the weighting.

Up until 2016, all blood lead results were rounded up or down when recorded in the data base. The reason for this practice is unclear but may have been related to the capabilities of the original Access® database. The minimum reading possible for capillary sampling is 3µg/dL compared to <1µg/dL for venous sampling. A "low result" reading is also possible and is recorded as 2 ug/dl. This affects the geomeans by slightly raising the average compared to those of the years where capillary testing was not available (before 2009). From 2016, all results were recorded with decimal places, so geomeans will not be exactly comparable to previous years but as population levels are reported here, the differences are likely to be slight and the trends in BLLs will still be meaningful.

Age-sex standardisation of results

Children's BLLs vary by age and gender, hence, it is difficult to compare BLLs from one year to another unless the same proportion of children in each age group is tested in successive years. Therefore age-sex standardisation is used to account for this variation. Effectively, this determines what the BLL would be if all children in Broken Hill were tested by applying the proportion of children to each age-sex group from the most recent Census data available. This age–sex adjusted population mean is reported for children aged 1 year to less than 5 years. Unadjusted means with 95% confidence intervals (2013 to 2022) are available in Appendix 1.

Data source

Until 2017, all children's demographics and BLLs were stored on a standalone Access® database. NSW Health ceased using Access® software and all data was loaded onto the new platform, the Powerchart/Community Health Outpatient Care (CHOC) application of the Electronic Medical Records from Cerner systems solutions. Maari Ma Aboriginal Health Corporation have continued to provide their blood lead screening data for loading onto the CHOC application.

Results

Screening of newborns, 2013 to 2022

Children screened

In 2022, of the 157 newborns[1], where umbilical cord blood screening was completed, 22% (n=34) are Aboriginal and 78% (n=123) are non-Aboriginal. For the 10 years from 2013 to 2022, there was a small decrease (5%) in the number of newborns screened for BLL, i.e., 166 to 157, respectively (Figure 1).

Blood lead levels

All newborns tested in 2022 had BLLs within the guideline (<5 µg/dL) and the annual geomean was 0.6 µg/dL. There was very little difference in geomeans between Aboriginal and non-Aboriginal infants i.e., 0.6 µg/dL compared to 0.7 µg/dL, respectively.

Due to a change in the recording of BLLs from 2016 onwards, comparisons to annual geomeans prior to 2016 is not possible (see Methods section for more information). As such, over the 7 years from 2016 to 2022, annual geomeans have decreased steadily from 0.8 µg/dL to 0.6 µg/dL, respectively (Figure 1).

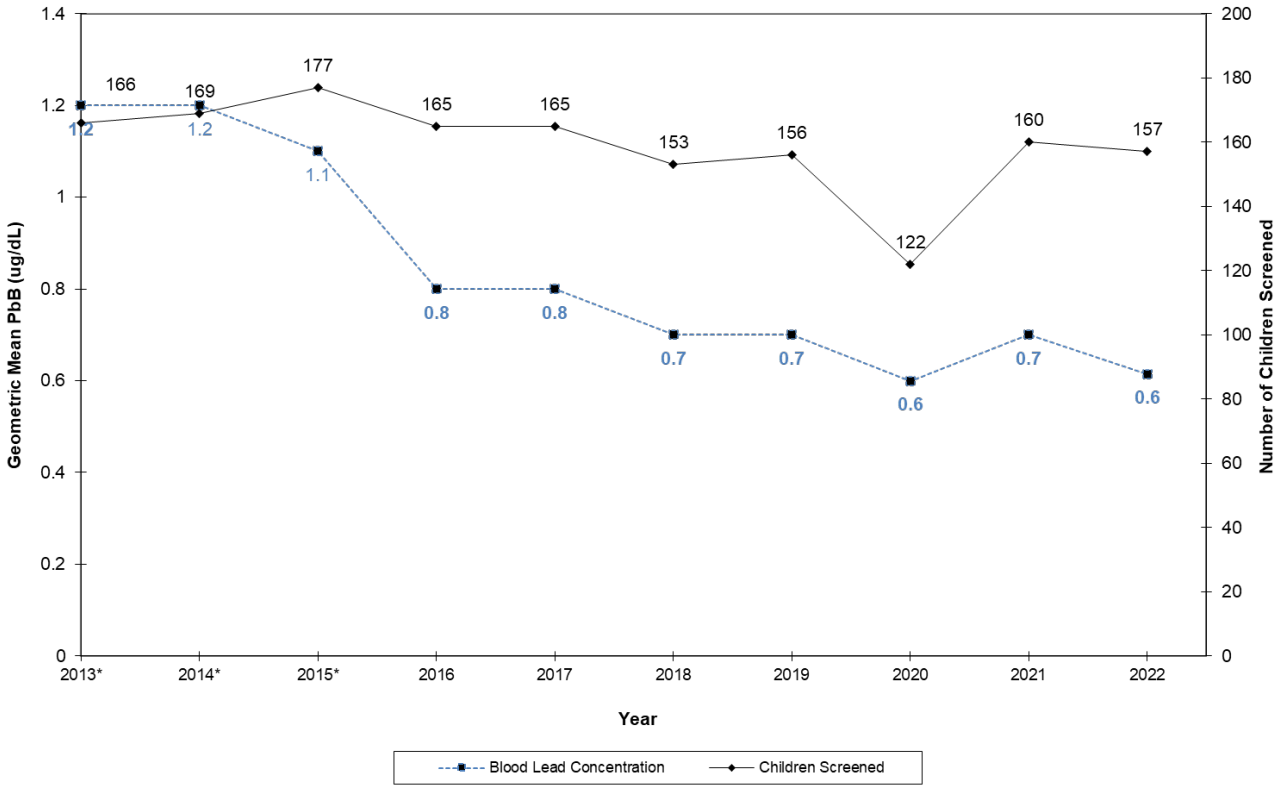

*Figure 1: Annual total of Broken Hill newborns screened and blood lead geometric mean, 2013-2022.Where: *Prior to 2016, BLLs were rounded up or down which particularly affects low results. As such 2013-2015 geomeans are not comparable to those from 2016 onwards where decimal points were recorded.*

[1] At time of publication, it was not possible to obtain data to determine the usual residence of the mothers giving birth at Broken Hill Hospital therefore a participation rate was not able to be determined.

Screening of children aged 6 months to less than 12 months, 2018 to 2022

Children screened

In 2022, 208 children aged 6 months to less than 12 months were screened for BLLs[2]. Of these children, 19% (n=40) are Aboriginal and 80% (n=166) are non-Aboriginal, with a small number (n=2) having no record for this indicator.

From 2013 to 2017, there was no screening of children aged 6 months to less than 12 months. For the five years from 2018 to 2022, the number of children screened for BLLs in this age group increased by 33%, i.e., from 156 to 208 (Figure 2). Following a steep drop off in the number of children screened in 2021, numbers increased by 30% in 2022, which is suggestive of a COVID19 pandemic artefact on participation in the Program in combination with the recall of the Lead Analyser Point of Care testing strips in September 2021. New testing strips were obtained by the 24th of January 2022.

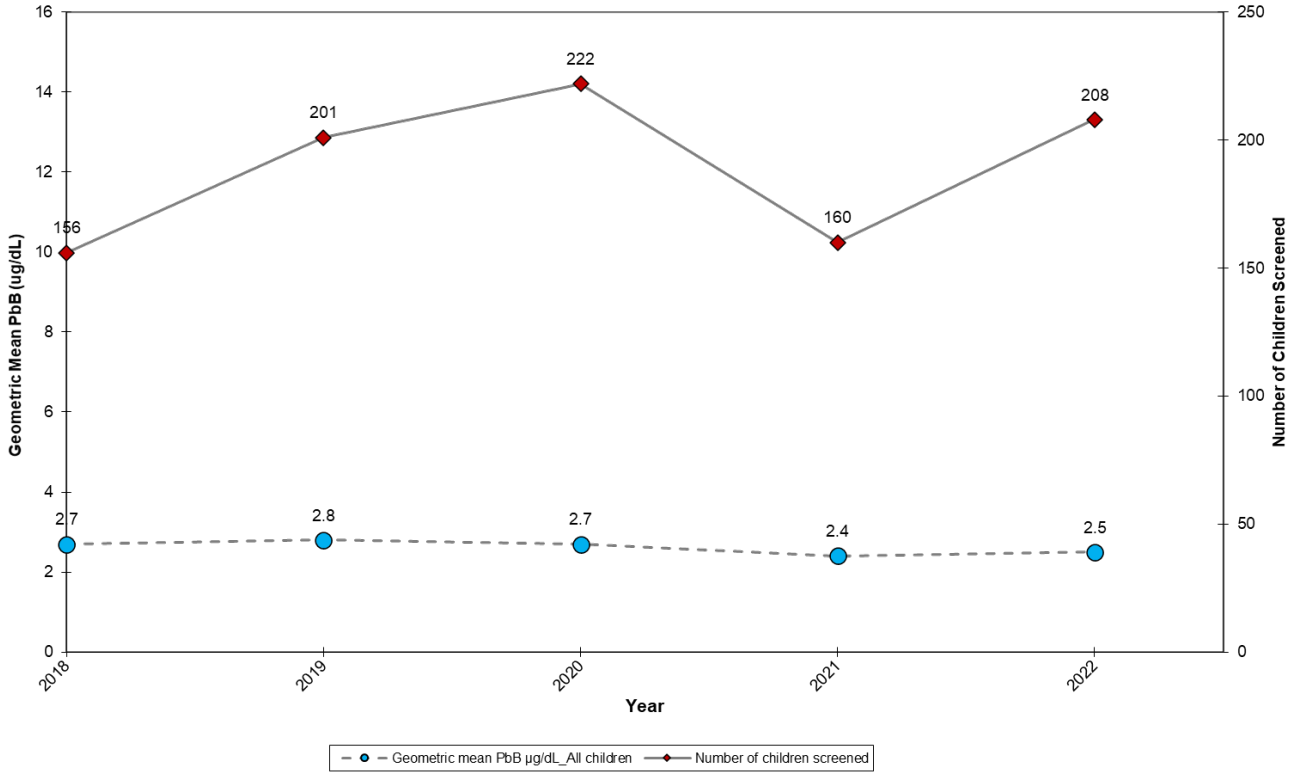

Figure 2: Annual number of Broken Hill children screened aged 6 months to less than 12 months and blood lead geometric mean, 2018-2022.

Blood lead geometric mean and elevated blood lead levels

In 2022, the geomean for all children aged 6 months to less than 12 months was 2.5 µg/dL. The geomean for Aboriginal children in this age group was higher than that for non-Aboriginal children i.e., 3.3 µg/dL compared to 2.3 µg/dL, respectively. From 2018 to 2022, there was a slight downward trend in the annual blood lead geomeans from 2.7 µg/dL to 2.5 µg/dL, respectively (Figure 2).

In 2022, 14% (n=29) of all children aged from 6 months to less than 12 months had BLLs above the guideline, which was double that for 2021 (7%) but equal to the average of the three previous years

[2] Participation rates have not been reported for this age group as an ABS Census denominator by six months is not available.

2018 to 2020 (Figure 3). The per cent of Aboriginal children with BLLs above the guideline in 2022 was three times that for non-Aboriginal children, i.e., 33% (n=13) compared to 10% (n=16), respectively.

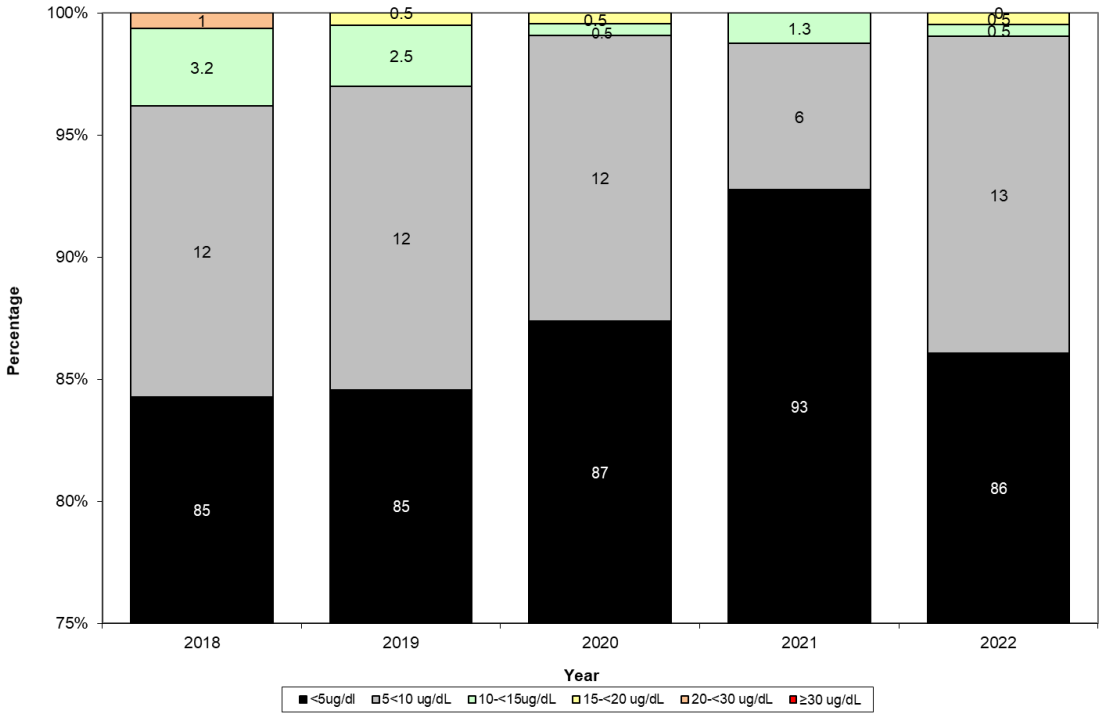

Figure 3: Per cent of Broken Hill children aged 6 months to less than 12 months blood lead levels by category, 2018-2022. NB: totals may vary due to rounding.

Screening of children aged 1 year to less than 5 years, 2013 to 2022

Children screened

In 2022, of the 619 children screened, 21% (n=127) are Aboriginal and 79% (n=489) are non-Aboriginal with a small number (n=3) having no record for this indicator. Over the 10-year reporting period from 2013 to 2022 there was an 11% decrease in the number of screened children aged 1 year to less than 5 years, i.e., from 695 to 619, respectively (Figure 6). This decrease corresponds with the 12% fall in the ABS Census population count of children aged 1 year to less than 5 years between 2011 and 2021, i.e., 886 to 784. [8]

From 2013 to 2022 the number of Aboriginal children screened for BLLs decreased by 19%, i.e., 156 to 127, respectively (Figure 4). While the number of non-Aboriginal children screened (including those children where there was no record for this indicator) decreased by 9%, i.e., 539 to 492, respectively. The decline in the number of Aboriginal children screened over the ten-year period is contrary to the significant increase in the ABS Census count of Aboriginal children aged under 5 years in 2011 compared to 2021 (Table 1).

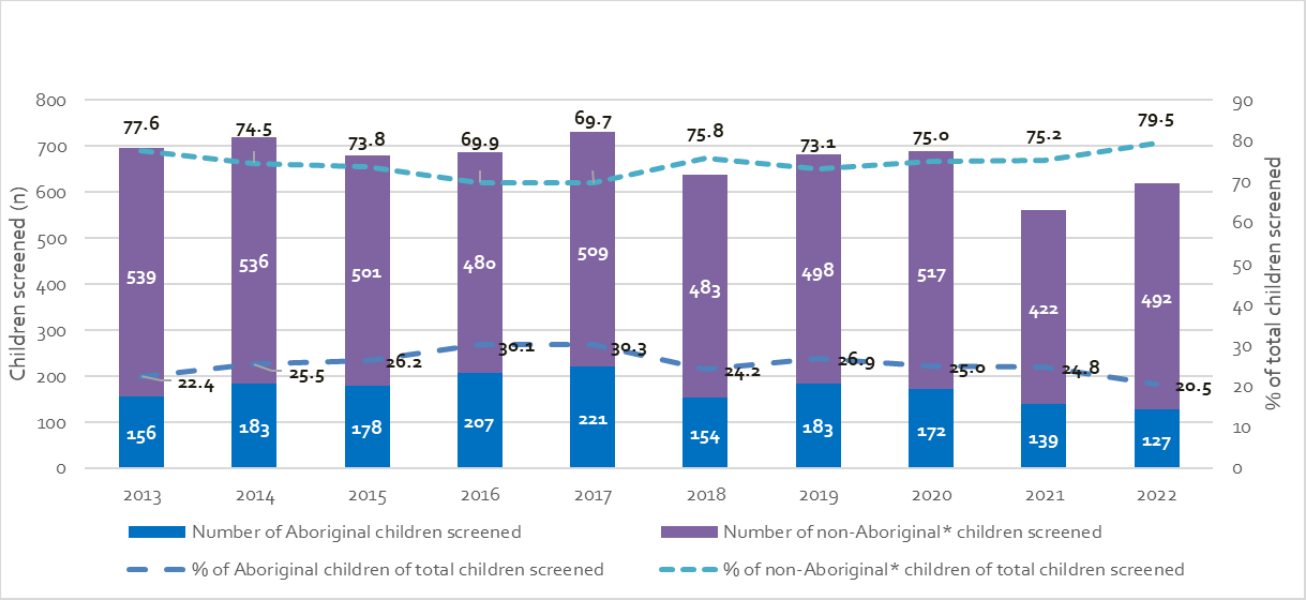

*Figure 4: Broken Hill number screened, and percentage of total children screened by Aboriginality, 1 year to less than 5 years screened for blood lead levels, 2013 to 2022. *non-Aboriginal screened include those children where this indicator was not recorded.*

Estimated participation rate

There was minimal change in the participation rates of all children aged 1 year to less than 5 years in 2013 to that in 2022 i.e., 78% to 79%. Looking more closely at the trends in participation over the 10-year reporting period, the 10-year average annual participation rate for this age group was 83% (Figure 5). Therefore, while the participation rate of 79% in 2022 is lower than the 10-year average, it is higher than that in 2021 (72%). Similarly, the estimated participation rate for Aboriginal children aged 1 year to less than 5 years in 2018 was 94%. In 2021, the participation rate for Aboriginal children fell to 86% but increased to 89% in 2022 and for all other years, exceeded 100%.[3]

NB: While the under reporting of Aboriginality in the Census has improved over time, the 2011 and 2016 counts are less than the total Aboriginal children tested in Broken Hill for the years 2013 to 2017 and 2019 to 2020. Consequently, a 10-year average rate was not calculated and participation rates for years 2018, 2021 and 2022 must be used with caution.

1 Trends should be interpreted with caution due to limitations with the data where the most recent ABS Usual Resident Population (URP) has been used as total population or denominator. This is not ideal as census requires a minimum residency period to be counted as a resident, where Aboriginal families may be more transient in their movements between extended family, and, in Broken Hill, the mining related workforce (and family) can ebb and flow depending on ore prices.

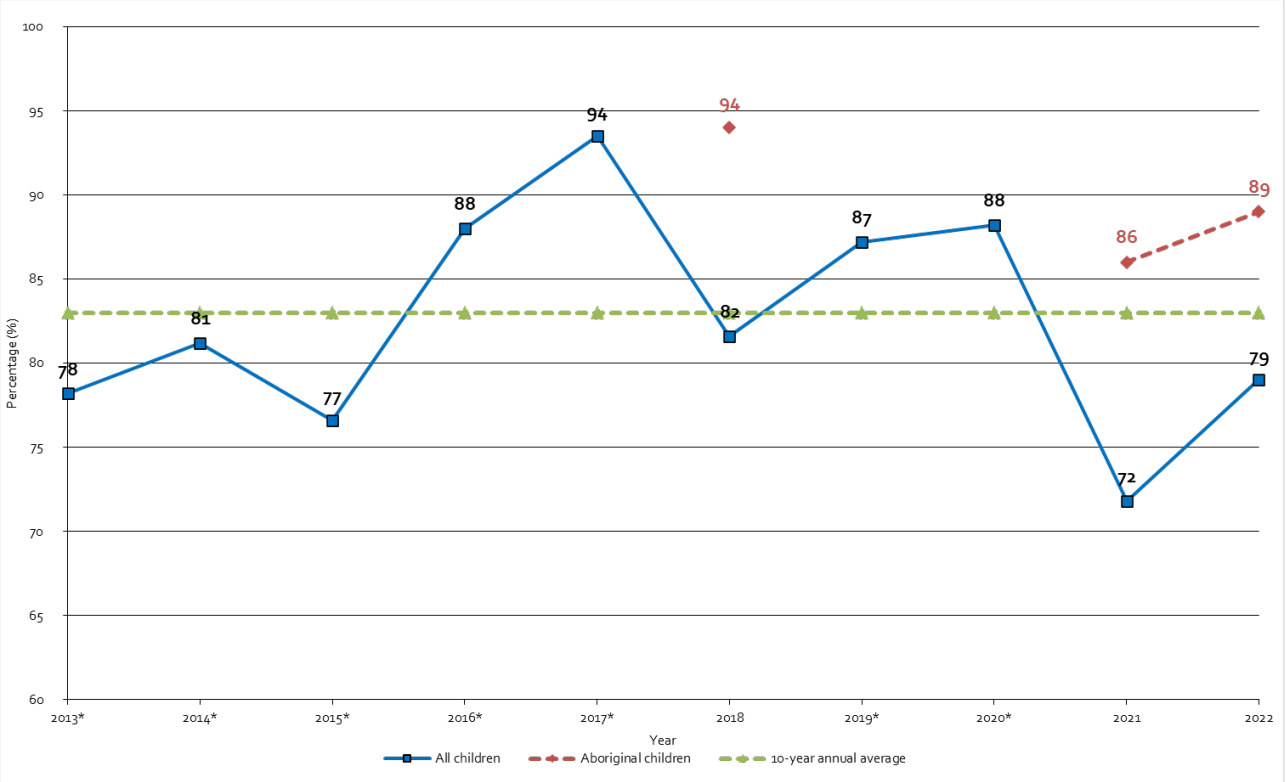

*Figure 5: Annual lead screening participation rate for all Broken Hill children and Aboriginal children aged between 1 and less than 5 years old, 2013-2022. *Participation rate for Aboriginal children exceed 100%.*

Blood lead geometric mean

In 2022, annual age-sex standardised BLL geomean for children aged from 1 year to less than 5 years was 4.1 µg/dL. Over the 10 years from 2013 to 2022 the standardised BLL geomean[4] decreased by 1.6 µg/dL from being above the guideline to below the guideline i.e., 5.6 µg/d to 4.1 µg/dL, respectively (Figure 6). In 2021, the standardised geomean for this age group decreased to a record low (3.6 µg/dL) which also corresponded to a record low number of children screened.

The annual age-sex standardised blood lead geomean for Aboriginal children aged from 1 year to less than 5 years in 2022 of 7.1 µg/dL was above the guidelines. However, from 2013 to 2022 the standardised geomean for Aboriginal children decreased by 1.1 µg/dL i.e., 8.2 µg/dL to 7.1 µg/dL, respectively (Figure 7). While in 2021, the standardised geomean for Aboriginal children screened decreased to a record low (4.7 µg/dL) and at the time the lowest number of children screened (n=139), 2022 saw an increase in the geomean but a further decline in the number of Aboriginal children screened (n=127).

[4] See Appendix 1 for Unadjusted geomeans plus 95% confidence intervals and age-sex standardised geomeans for all children aged 1 to <5years in Broken Hill, 2012-2021

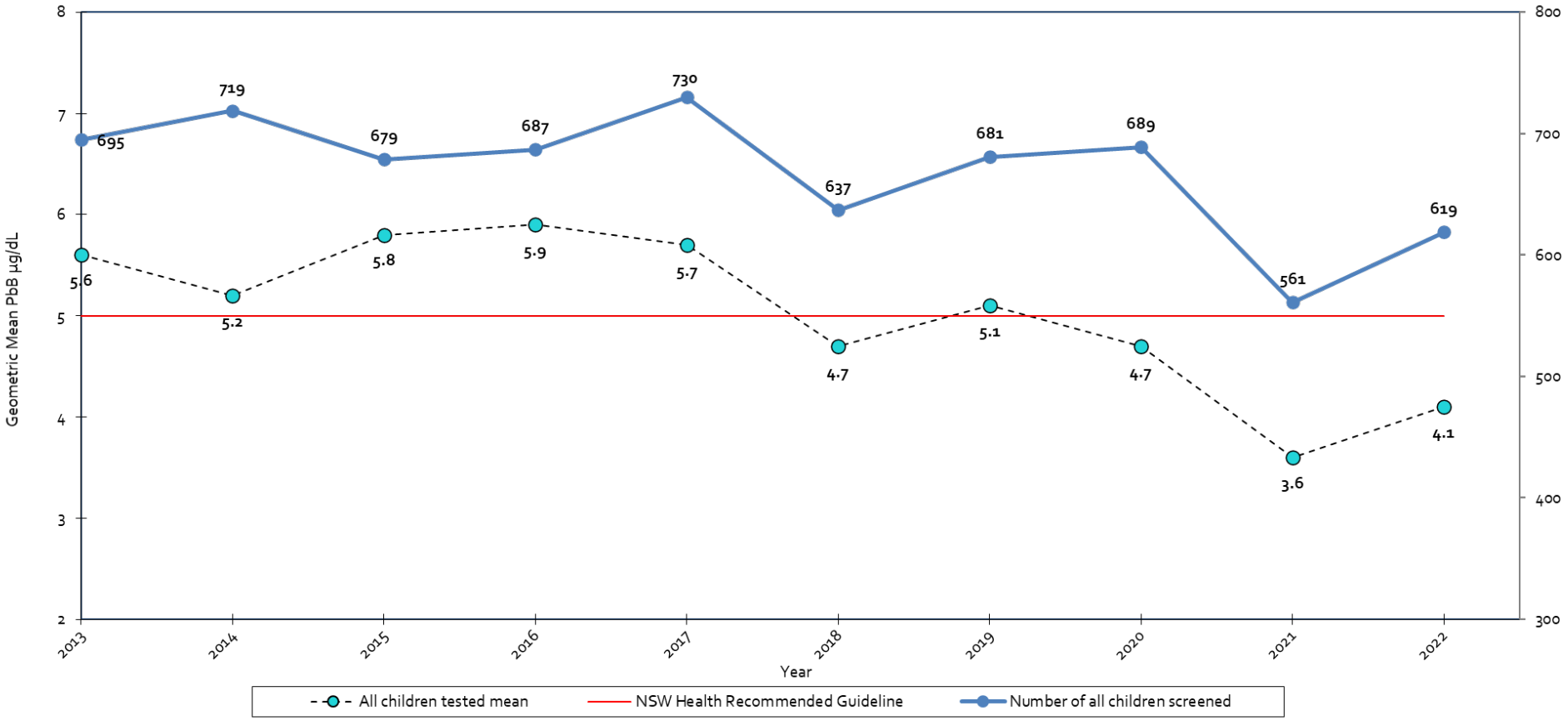

Figure 6: Annual number of Broken Hill children screened aged 1 to < 5 years and population age-sex standardised geometric mean blood lead concentration compared to the NSW Health recommended guideline (<5.0 µg/dL), 2013 to 2022.

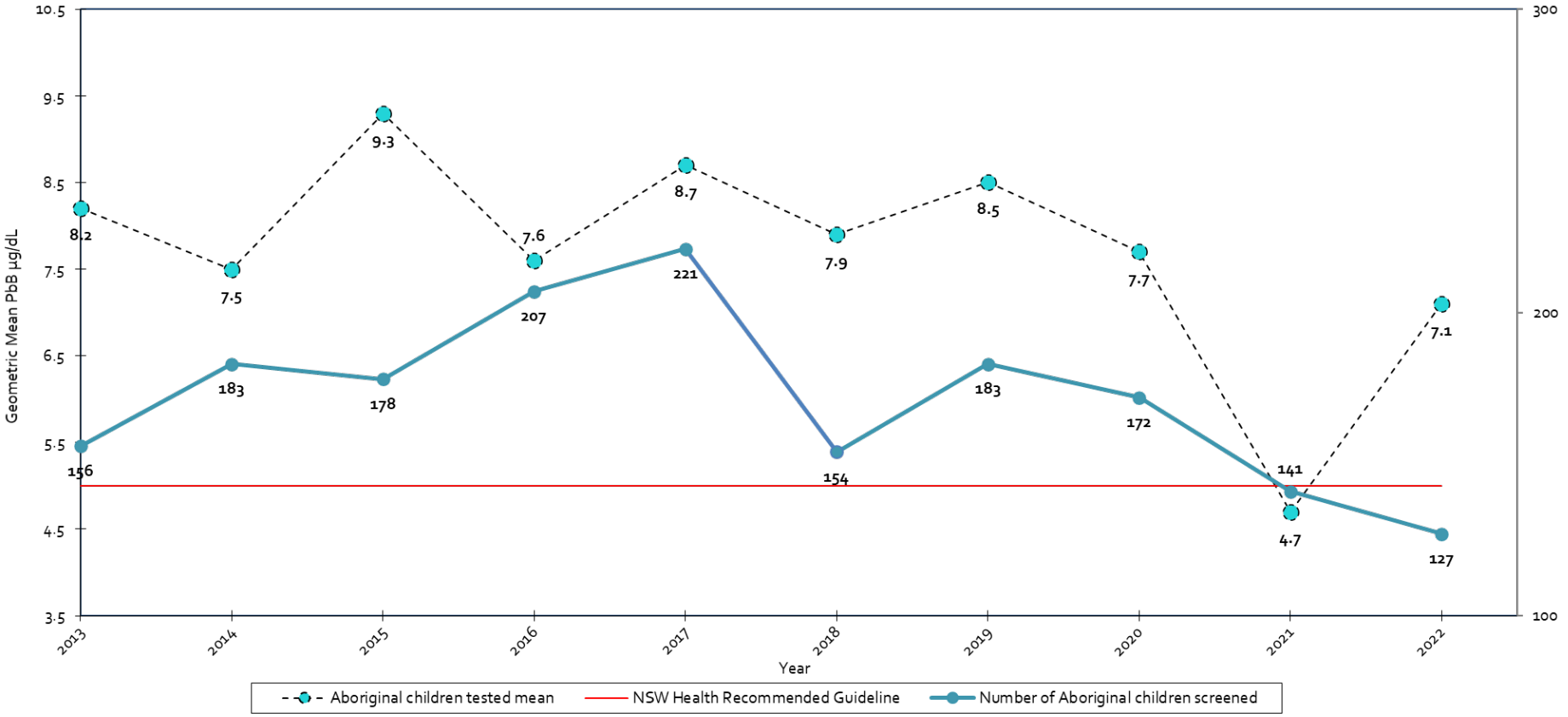

Figure 7: Annual number of Broken Hill Aboriginal children aged 1 to < 5 years screened and the Aboriginal population age-sex standardised geometric mean blood lead concentration compared to NSW Health recommended guideline (<5.0 µg/dL), 2013 to 2022

Elevated blood lead levels

In 2022, the age-sex standardised per cent of all children aged from 1 year to less than 5 years with BLLs above the guideline was 39% which equates to 306 children, based on the 2021 ABS census data. The standardised per cent of Aboriginal children aged from 1 year to less than 5 years with BLLs above the guideline was 66% which equates to 94 children.

From 2013 to 2022, the age-sex standardised per cent of all children aged 1 year to less than 5 years screened with BLLs above the guideline has decreased from 53% to 39%, respectively. Over the 10-year reporting period, there was a decrease in the per cent of children with BLLs ranging from 5 to less than 10 µg/dL (32% to 27%) and from 10 to less than 15 µg/dL (13% to 7%) (Figure 8). However, the per cent of children estimated to have levels 30 µg/dL or above is the same as that in 2013. Meaning that very high BLLs in a small number of children in this age group persist.

The per cent of Aboriginal children aged 1 year to less than 5 years screened with BLLs above the guideline has decreased over the reporting period from 77% in 2013 to 66% in 2022, with an average annual per cent of 73% over the 10-year period (Figure 9). While the per cent of Aboriginal children with BLLs ranging from 5 to less than 10 µg/dL has increased (35% to 40%) the per cent with BLLs from 10 to less than 15 µg/dL has decreased (23% to 14%). Importantly, however, the per cent of Aboriginal children with very high BLLs, 30 µg/dL, has increased from 3% in 2013 to 5% in 2022, noting that a smaller number of children were tested in 2022 compared to that in 2013.

In 2022, when comparing the BLL categories percentages for Aboriginal to non-Aboriginal children aged 1 year to less than 5 years (Figure 10), large discrepancies are evident for levels below the guideline (34% vs 69%, respectively) and 10 to less than 15 µg/dL (14% vs 4%, respectively). In particular, 8% of Aboriginal children (which equates to 11 children) were found to have high or very high BLLs compared to less than 1% of non-Aboriginal children (which equates to 6 children).

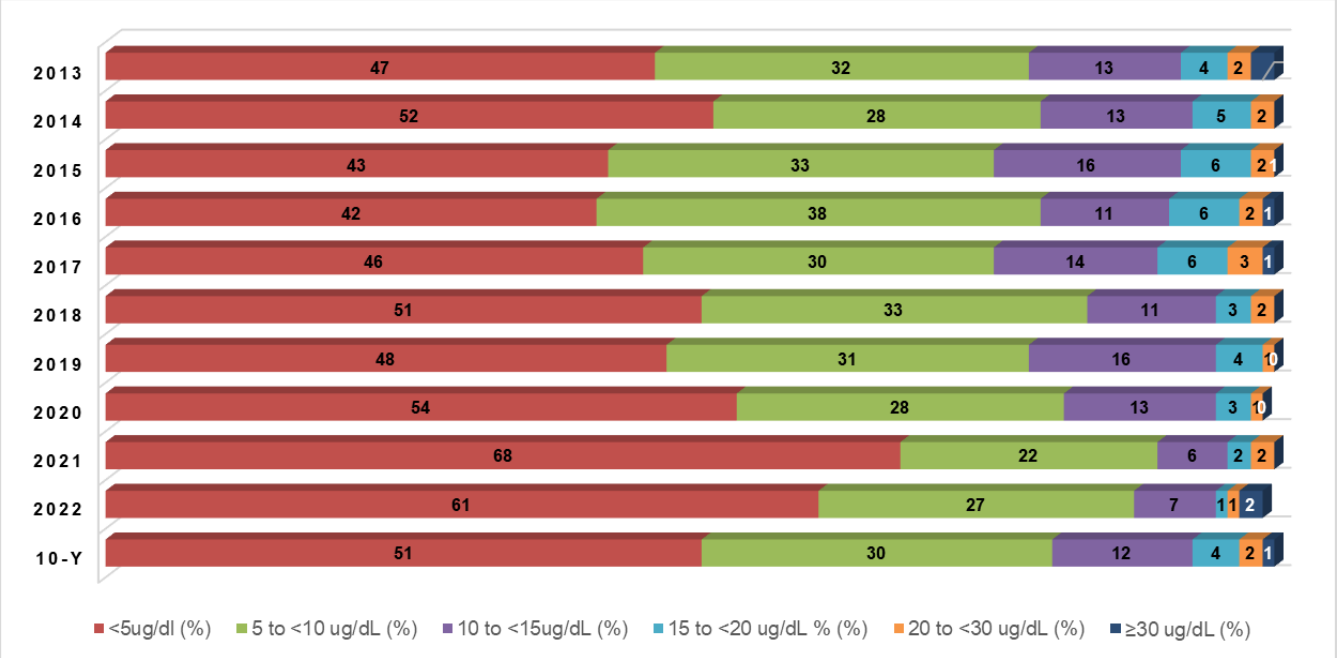

Figure 8: Children aged 1 to less than 5 years blood lead levels by category as a per cent of total, (age-sex standardised per cent), Broken Hill, 2013-2022

NB: totals may vary due to rounding.

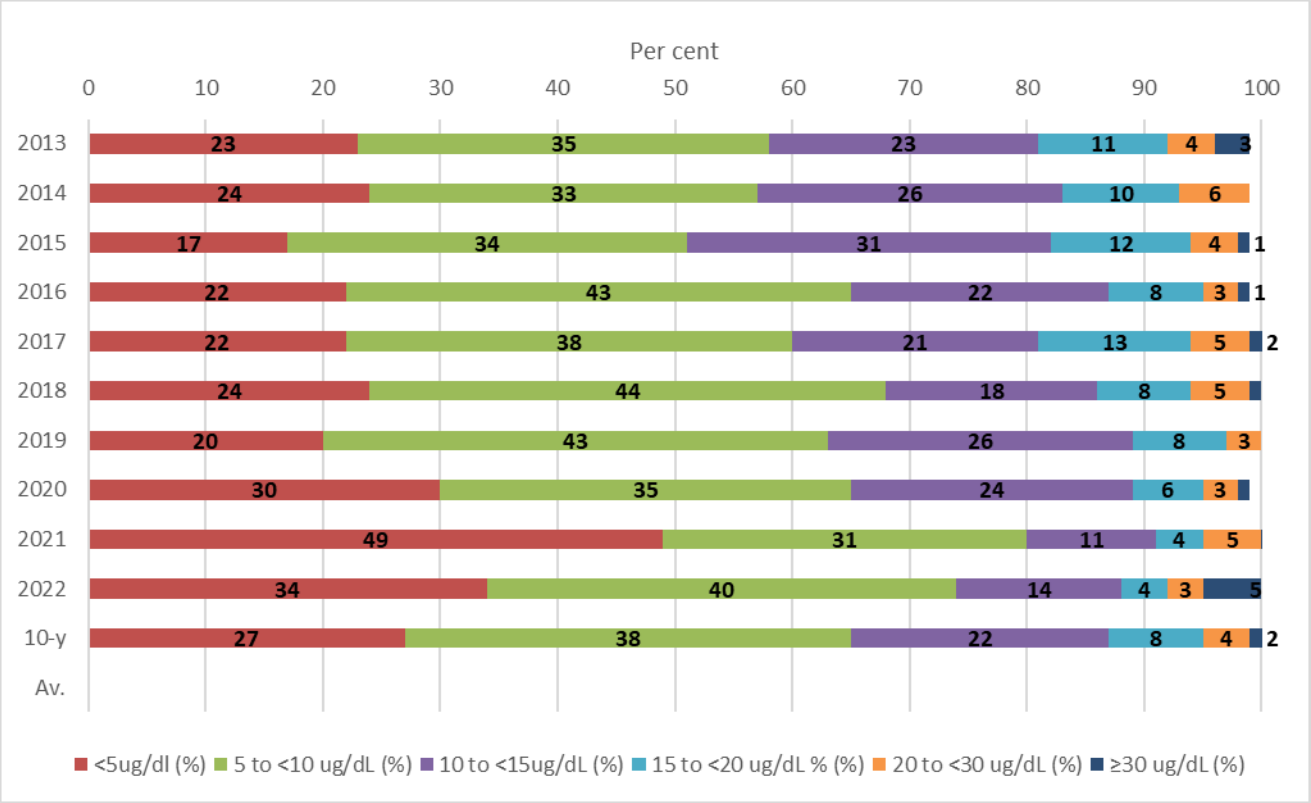

Figure 9: Aboriginal children aged 1 to <5years blood lead levels by category as a per cent of total, Broken Hill, 2013-2022

NB: totals may vary due to rounding.

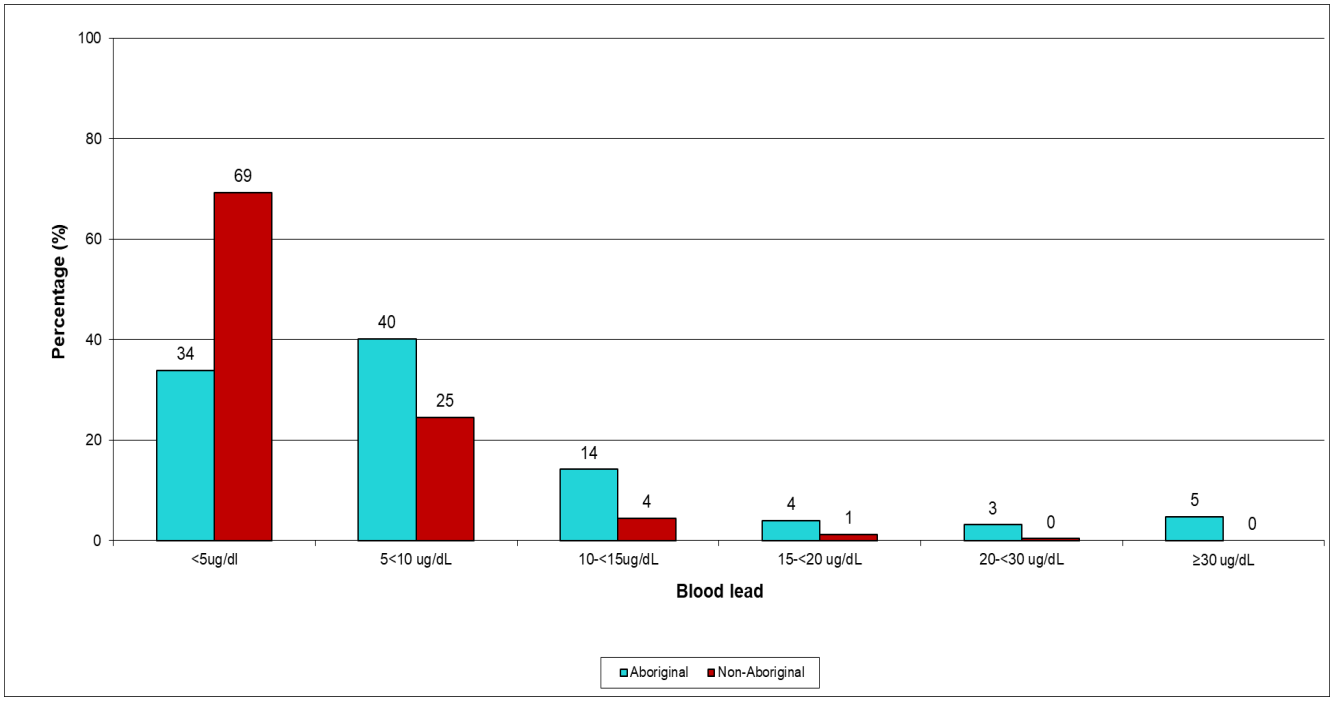

Figure 10: Comparison of Aboriginal versus non-Aboriginal children aged 1 to <5 years by blood lead categories per cents, 2022.

Seasonal trends in blood lead levels of all children aged 1 to < 5 years, 2022

A study by Liu et al, 2021[9] of BLLs in Broken Hill children aged under 5 years from 1991 to 2015 found that higher BLLs are associated with the warmer months (October to March) and lower BLLs in the colder months (April to September). However, an association with seasons in 2022 is less apparent with BLL geomeans for children aged 1 year to less than 5 years being highest in the first quarter (January to March) and third quarter (July to September), i.e., 4.4 µg/dL and 4.1 µg/dL, respectively.

In 2021, the lowest annual BLL geomean for Broken Hill children since The Program began occurred concurrently with a very high annual rainfall (251.1 millilitres). There was some suggestion that the high rainfall may have contributed to the low BLL geomean. However, in 2022, where there was an increase in the annual geomean from that in 2021 (4.1 µg/dL compared to 3.6 µg/dL), the annual rainfall was more than double that for 2021, and the highest on record (558.8 millilitres[10]). As such, an association between lower BLLs and high rainfall is less clear.

In 2022, the highest numbers of first tests occurred in the first (n=174) and second (n=213) quarters of the year, which is consistent with findings for previous years. However, there is no obvious association between high testing numbers and higher geomeans (Figure 9).

Therefore, for 2022 it is not possible to draw any clear conclusions about seasonal trends in geomeans and their associations with weather or number of children screened.

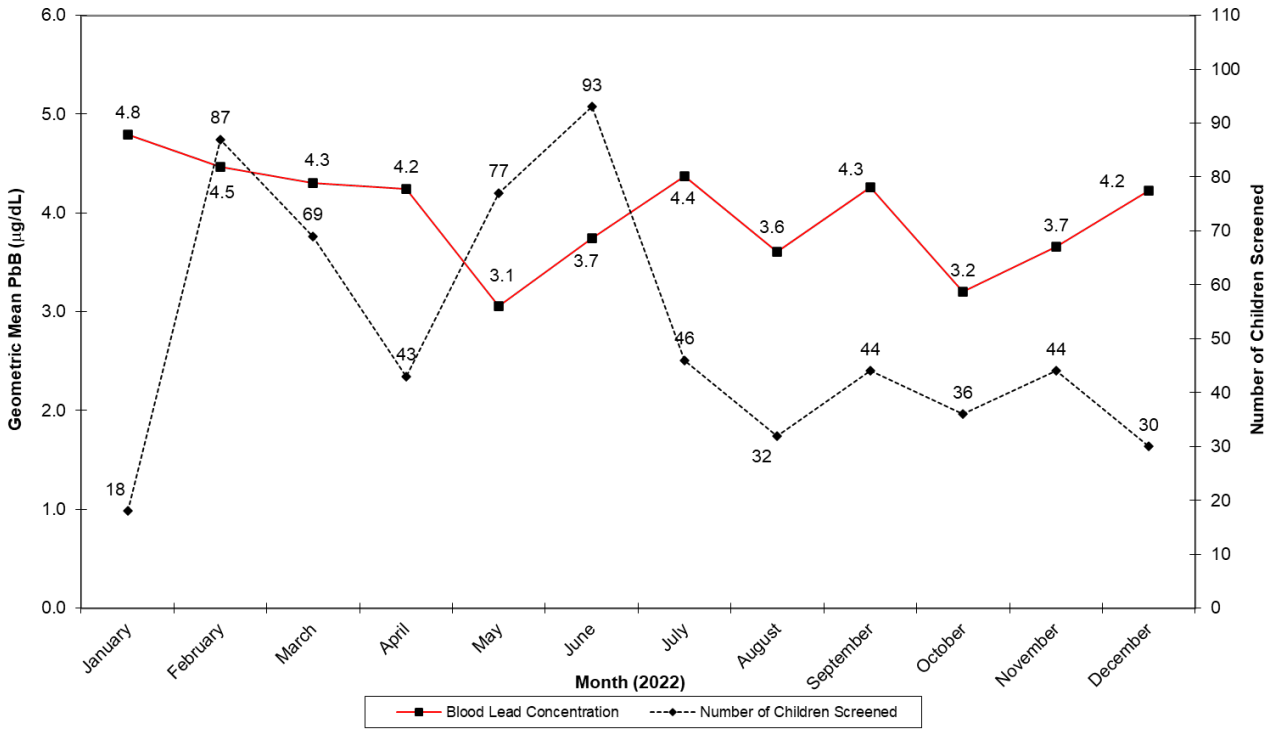

Figure 11: Monthly geometric mean blood lead level comparison of first visit blood lead levels for Broken Hill children aged between 1 to <5 years of age, 2022.

Conclusion

In 2022, the Broken Hill Lead Program saw an increase in the number of children screened across two of the three developmental groups compared to considerable declines seen in 2021. While the number of newborns screened fell minimally from 2022 to 2021, numbers for all children aged 6 months to less than 12 months and 1 year to less than 5 years, saw marked improvements. Trends over time show that the number of newborns being screened remain relatively stable, with increases seen for children aged 6 months to less than 12 months but a small decline, in line with an overall decline in the ABS count, for children aged 1 to 5 years. Trends in the estimated participation rates for all children aged 1 year to less than 5 years overall have remained stable such that 4 in every 5 children in this age group has participated in the Program.

Analyses of geomeans across the developmental groups confirm that for newborns, geomeans are low and act as a proxy baseline for children as they grow and develop with no differences seen between Aboriginal and non-Aboriginal newborns. As children develop and begin to interact with their environment (6 months to less than 12 months) by rolling, crawling, and grabbing at objects the geomean increases but remain well within the guideline. Once children become toddlers (i.e., 1 year and older) they have greater freedom to roam and explore. This increases children's exposure to lead, and it is when BLLs rise close to or above the guideline. 10-year trends for children aged 1 year to less than 5 years has seen geomeans in this age group fall from above the guideline to below the guideline.

Numbers of Aboriginal children aged 1 year to less than 5 years being screened for BLL has declined over time with the lowest number screened in 2022 for the 10 years from 2013 to 2022. This decline in testing numbers is contrary to an increase in the ABS count of Broken Hill Aboriginal children in this age group. Further, while annual geomeans for Aboriginal children over time have fallen, the 2022 geomean was above the guideline and the rates of high or very high blood levels in Aboriginal children persisting.

Appendix 1: Unadjusted geomeans, with 95% CI

Table 2: Broken Hill children aged 1 year to less than 5 years Unadjusted annual geomeans with 95% confidence intervals, and age-sex std GMs 2013-2022.

Year	Children tested	Unadjusted geomean	95 CI+	95 CI -	age-sex std GM
2013	695	5.5	5.99	5.21	5.6
2014	719	5.1	5.53	4.87	5.2
2015	679	5.7	6.16	5.44	5.8
2016	687	5.8	6.31	5.49	5.9
2017	730	5.5	6.09	5.31	5.7
2018	637	4.6	5.08	4.32	4.7
2019	681	5.1	5.45	4.75	5.1
2020	689	4.7	5.04	4.36	4.7
2021	561	3.5	3.82	3.16	3.6
2022	**619**	**3.9**	**4.39**	**3.44**	**4.1**

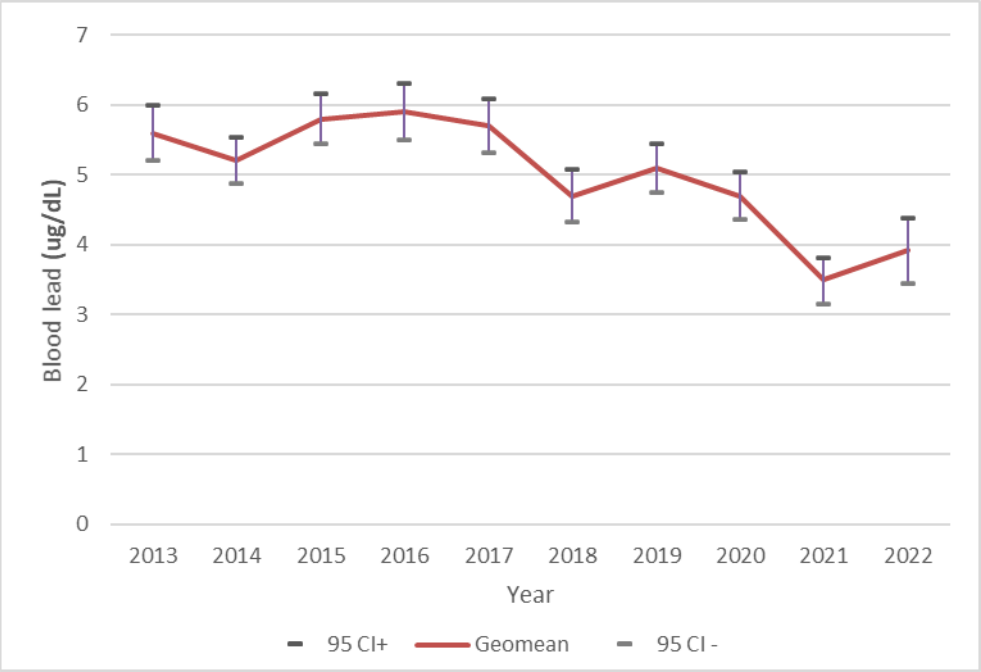

Figure 12: Children aged 1-<5 years, annual geomeans with 95% confidence intervals, 2013-2022

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