mount isa community

[LEAD SCREENING PROGRAM 2006~7]

A report into the results of a blood-lead screening program of 1–4 year old children in Mount Isa, Queensland.

Queensland Government
Queensland Health

This report was prepared by Environmental Health Services of the Tropical Population Health Network, Northern Area Health Service, Queensland Health.

The report was independently reviewed by an environmental toxicology specialist, Professor Michael Moore.

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Executive Summary

There is a long history of lead mining and associated activities in Mount Isa. This combined with naturally occurring lead in the environment and its persistence mean that there are elevated levels of lead in parts of the environment of Mount Isa. The presence of lead in the environment and its potential to elevate blood lead levels in those living and working there has been acknowledged for many years. The ongoing collaboration between the mining company, the Mount Isa City Council and various state government agencies, including Queensland Health has therefore focused on ways to manage potential lead exposures and provide advice and support for the families of children found to have elevated blood lead levels.

At the population level, past epidemiological studies have reported adverse health effects in young children at blood lead levels of 10 µg/dL and above. Exposure to lead in early childhood is associated with impaired cognitive development. Features of high blood lead levels may include reduced attention span, reduced spatial skills, poorer performance at school, haematological changes, and behavioural problems. Though there is no current specific health guideline in Australia for blood lead levels Queensland Health has adopted the public health goal of achieving blood lead levels below 10 µg/dL concordant with WHO standards in order to best manage community lead exposure in Queensland. At blood lead levels less than about 20 µg/dL however, clinical symptoms or signs of acute toxicity would not be expected.

In 2006, Queensland Health commenced a study in Mount Isa of children between one and four years old in order to determine blood lead levels in this age group. Children were recruited by invitation. The 400 recruited for the study were found to be representative of the general population of one to four year olds in Mount Isa in terms of age, sex and Indigenous status.

Children were encouraged to be tested over a period of 14 months through an extensive media campaign titled 'Get Bled for Lead'. The 'Get Bled for Lead' campaign served two purposes – it provided awareness and information on how to participate in the study and also provided general information to the community on how to minimise their potential lead exposure.

Results of the study indicate that the average blood lead level (geometric mean) for the group of children sampled was 5.0 µg/dL, with a minimum value of 1.3 µg/dL and maximum value of 31.5 µg/dL. Forty-five children (11.3% of those in the study group) had blood lead levels greater than or equal to 10 µg/dL. Of these, two children had blood lead levels greater than 20 µg/dL.

Statistical analyses revealed significant associations between blood lead levels greater than or equal to 10 µg/dL and Indigenous status and age. Indigenous children were approximately four times more likely (OR 4.3) to have a blood lead level of greater than or equal to 10 µg/dL than non Indigenous children. For all participants the likelihood of having a blood lead level of ≥10 µg/dL was found to be reduced by 4% for every one month increase in age. Analysis also demonstrated no statistically significant associations between blood lead levels and the variables of sex or length of time in Mount Isa.

Household audits carried out for those children with elevated blood lead levels (equal to or greater than 10 µg/dL) indicated that factors such as chewing, sucking or eating non food items, residing in a property with bare soil and pet ownership were common in this group. These factors have been consistently reported to be associated with elevated blood lead levels in children in studies at other locations.

On the basis of results of the study, Queensland Health has focused on a range of individual follow up activities as well as continuing population focused strategies for improving awareness and encouraging behavioural modification for the greater Mount Isa community. For those households where children had elevated blood lead levels, individual follow up activities will continue to focus on:

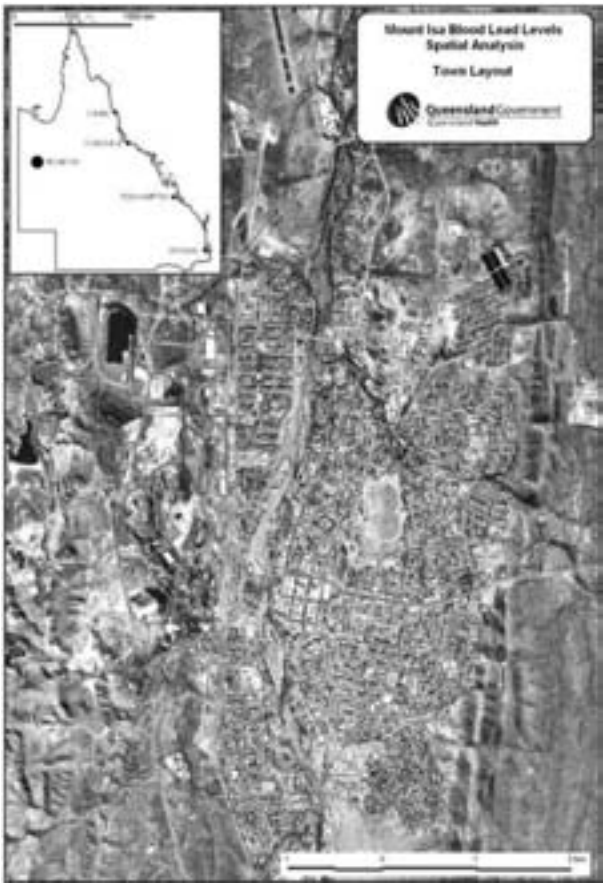
- auditing of environments and collection of soil/paint/dust samples at other places where the child spends significant time,
- advice with modifying the home environment, and identifying child hand-mouth behaviours and practices that may lead to exposure,
- dietary investigation and advice,
- additional blood testing to determine if exposure prevention strategies are reducing blood levels, and
- referral to a paediatric specialist where blood lead results are above 20 µg/dL.

Queensland Health continues to encourage community uptake of the free blood lead testing service at Queensland Medical Laboratory Pathology Services and will closely monitor results of any testing. In addition Queensland Health will continue to work with key partners through the Living with Lead Alliance to develop long term strategies for lead management in Mount Isa.

Contents

1.0 Background

Mount Isa City is located in North West Queensland and has an estimated resident population of 21,082 in 2006, of which 4,099 (19%) identified themselves as Indigenous (Australian Bureau of Statistics 2006a). The estimated population for children aged one to four years in Mount Isa City was 1,485 and of those 396 (26.7%) identified as Indigenous (Australian Bureau of Statistics 2006b).



Mount Isa was established because of the vast mineral deposits in its immediate vicinity. In 1923, John Campbell Miles discovered a rich seam of silver-lead ore on the western edge of the Cloncurry mineral field at Mount Isa. Copper and zinc are also mined in the area. Copper, lead and silver are smelted on site, with products transported 900km to Townsville.

Xstrata Plc currently operates the Mount Isa Mines facility, which is located to the immediate west of the city. The Mount Isa Mines complex includes crushing plants, mills, concentrators and two smelters. The mining sector is the largest employer in the Mount Isa region, employing around 27% of the region's employed population (ABS 2006c).

WHAT IS LEAD?

Lead is a dense, low melting point, bluish-grey metal that occurs naturally in the Earth's crust. However, it is rarely found naturally as a metal. It is usually found combined with two or more other elements to form lead ores which are mined and smelted. Lead is a metallic element and cannot degrade.

Even though lead occurs naturally in the environment, most of the high levels found throughout the environment come from human activities. Lead can enter the environment through releases from mining lead and other metals, and from factories that make or use lead, lead alloys, or lead compounds. Lead is released into the air during burning coal, oil, or waste. Before the use of leaded petrol was banned, much of the lead released into the Australian environment came from vehicle exhaust. Another common source of lead was lead-based paint. Though the amount of lead in household paint was significantly restricted in the early 1970s, it still exists in the paint of older homes throughout Australia.

The greatest increase in environmental levels of lead, in most locations, occurred between the years 1950 and 2000. This was mainly due to increasing worldwide use of leaded petrol. Since the introduction of unleaded petrol in Australia in 1996, the reduction in lead content of leaded petrol from 0.84g/L in 1990 to 0.2g/L in 1996, and then the complete ban of leaded petrol in 2001, there has been a steady decline of levels of motor vehicle-related lead in the air in monitored sites in Queensland. This decline has been so significant that the Environmental Protection Agency's airborne lead monitoring program (relating to motor vehicle lead emissions) ceased at the end of 2002 (EPA, 2003).

Though lead is no longer a major pollution problem for most parts of Australia, there are still populated areas of Australia where industrial activities associated with mining and smelting of lead contribute to environmental levels of lead that need to be carefully managed. These areas include Mount Isa in Queensland, Port Pirie in South Australia and Broken Hill in New South Wales.

HOW ARE PEOPLE EXPOSED TO LEAD?

The general population may be exposed to lead in ambient air, foods, drinking water, soil, and dust. Segments of the general population at the highest risk of health effects from lead exposure are preschool-age children and pregnant women and their fetuses. Other segments of the general population at high risk include individuals living near sites where lead is or was produced or disposed of, and people who work with lead.

Exposure to lead occurs mainly through ingestion and inhalation of dust and air contaminated by lead. Children commonly play in dirt and dust and their hand-to-mouth behaviour means that ingestion of lead is an important pathway (Simon et al., 2007, Ko et al., 2007).

Extreme cases of this hand-to-mouth behaviour are referred to as pica. Pica is an eating disorder typically defined as the persistent eating of non-nutritive substances for a period of at least one month at an age at which this behaviour is developmentally inappropriate (e.g. > 18-24 months). Pica is most common in young children in their second and third years of life (Ellis and Schnoes, 2006).

ROLE OF DIET

One of the keys to minimising the effects of lead in children is to minimise the amount of lead that actually gets absorbed into their system. A child's body needs certain minerals such as calcium and iron, and when these minerals are deficient in the body, lead absorption is increased. Good nutrition, which includes an adequate intake of calcium and iron, lowers the proportion of swallowed lead that passes to the bloodstream. Various studies have shown that gastrointestinal absorption is greater when the stomach is empty. Pulmonary absorption is generally greater than gastrointestinal absorption.

BLOOD LEAD LEVELS IN AUSTRALIA

Blood lead levels are commonly used as a marker of exposure to lead in humans and are generally reported in micrograms (µg) per decilitre (dL) of blood. The blood lead level of a newborn baby typically reflects that of the mother and as infants become more active and increase their environmental exposure, their blood lead levels increase. Studies of lead exposed children typically show that blood lead levels increase in late infancy and peak between 18 to 36 months of age (Binns et al, 2007). This relates to increased activity and increased potential for environmental exposure.

The last national survey of blood lead levels in Australia was conducted in 1995 by the Australian Institute of Health and Welfare (Donovan J, AIHW, 1996), where 1575 children aged 12-60 months from all states and territories were sampled. Results indicated that of the children sampled for the study, 92.7% had blood lead levels < 10 µg/dL, 7.3% had blood lead levels ≥ 10 µg/dL, 1.7% had blood lead levels ≥ 15 µg/dL and 0.25% had blood lead levels ≥ 25 µg/dL. The mean (arithmetic) blood lead level was 5.72 µg/dL and the mean (geometric) blood lead level was 5.05 µg/dL. The maximum blood lead level reported was 32.7 µg/dL. For Queensland, where 270 children were sampled, the arithmetic mean was 5.59 µg/dL and 95.2% of the sample had blood lead levels < 10 µg/dL.

HEALTH EFFECTS OF LEAD EXPOSURE

Children under the age of five are at greatest risk of health effects of lead exposure. This is because:

- the brain in young children is still maturing and appears to be more vulnerable to lead
- exploratory hand-to-mouth activity of children places them at higher risk of ingesting lead from a contaminated environment
- children absorb a much higher proportion of ingested lead than adults (40 - 50% compared to 3 - 10% for adults).

Population-based epidemiological studies have found exposure to lead in early childhood to be associated with impaired cognitive development (ATSDR, 2007). At blood lead levels less than 20 µg/dL, clinical symptoms or signs of acute toxicity would be unexpected. Symptoms of higher blood lead levels may include reduced attention span, reduced spatial skills, poorer performance at school and behavioural problems. Lead can pass from mother to the unborn baby and therefore maternal exposure to lead in pregnancy can affect the unborn baby.

Symptoms in adults depend on the level of exposure. High levels can cause joint and muscle pain, muscle cramps, anaemia, nausea, constipation, colicky abdominal pain, sleep problems, reduced concentration and headaches. At very high levels (greater than 80 µg/dL) lead may cause encephalopathy (i.e. a disease of the brain) and convulsions. Lengthy high level exposure to lead can also be associated with chronic renal damage.

IS THERE A 'SAFE' LEVEL?

Population-based epidemiological studies have consistently reported adverse effects in children at blood lead levels of 10 µg/dL and above. Intelligence quotient (IQ) is used in many of the studies as an indicator of developmental effects in children. Blood lead concentration is associated with lower IQ scores as IQ becomes testable reliably, which is at approximately five years of age. The strength of association is similar from study to study; as blood lead concentrations increase by 10 µg/dL, the IQ at five years of age and later decreases by two to three points (American Academy of Pediatrics, 2005). This is observed as a lifetime average blood lead concentration and not the result of an acute exposure.

A growing number of publications suggest that blood-lead levels below 10 µg/dL may lead to subtle developmental effects (for example, measured as IQ decrements) in children. A recent review of published literature has examined health effects relating to physical and mental development in children below 10 µg/dL (Binns et al, 2007). It concludes that there is an inverse association between blood lead levels and IQ at levels below 10 µg/dL, but the influence of other social factors that may also influence IQ made it difficult to adequately describe the strength and shape of this relationship. This information suggests that prevention activities should be initiated to reduce the levels of lead in the blood to as low as possible.

There is no specific health guideline in Australia for blood lead levels. In 1993, the National Health and Medical Research Council (NHMRC) stated that the specific goal was 'to achieve for all Australians a blood lead level of below 10 micrograms per decilitre (0.48 micromoles per litre)' (NHMRC, 1993). This document also recommended a graduated response to blood lead levels for both individuals (children of all ages over 15 µg/dL) and communities where >95% of one to four year old children were below 25 µg/dL, but >5% were above 15 µg/dL. This guideline was rescinded in 2005 and is currently being reviewed. The stated public health goal is consistent with other current international guidelines from organisations such as the United States Centers for Disease Control and the World Health Organization, and is the goal that Queensland Health has adopted to manage community lead exposure in Queensland.

HOW BLOOD LEAD LEVELS ARE ROUTINELY MONITORED AND RESPONDED TO IN QUEENSLAND

Under the Public Health Regulation (2005), elevated blood-lead levels are a notifiable condition – this means that if a pathology laboratory identifies elevated blood lead levels then Queensland Health must be notified. There is a clear delineation between occupational exposures versus those from a non-occupational setting.

When a notification is received, Queensland Health staff and the attending medical practitioner investigate and attempt to identify the source of exposure. If the notification relates to children, the investigation should involve an inspection of the local environment of their home, and in some cases environmental sampling may be carried out. Parents or guardian are advised of the nature of the condition, potential or identified sources of exposure and how to reduce exposure. Follow-up testing of the blood lead level is recommended to ascertain the effectiveness of implemented exposure control measures (Queensland Health, 2006).

The level of response should be proportionate to the blood lead level. When children's blood lead levels reach 20 µg/dL they should be referred to a medical practitioner, such as a paediatrician, for additional medical investigation and support. For high blood lead levels in children (for example, over 45 µg/dL) chelation therapy is a treatment method which may be considered depending on the clinical circumstances. Below this level, the most effective approach is to work with affected families to identify and control environmental lead exposure and to provide dietary advice to help reduce blood lead levels and keep them low.

Reducing home environment risk factors through taking personal protective measures is generally very effective in reducing blood lead levels. However a reduction may not happen quickly. Once an elevated blood lead level has been detected in a child, the time required for the level to decline to < 10 µg/dL can range from months to years (Binns et al, 2007).

Queensland Health has also published statewide blood lead notification data in annual reports since 2002, which are available at www.health.qld.gov.au

LEAD IN MOUNT ISA

The City of Mount Isa is located in a region that contains numerous mines. The Mount Isa mine is one of the largest copper and lead-zinc mines and smelter operations in the world. Outside the actual Mount Isa mining area there is a low grade periphery of the lead-silver-zinc orebody that extends into some community areas.

There have also been a number of historic events whereby lead-containing material was transported into the community, and where contamination of the Leichhardt River bed occurred.

The lead smelter and associated mineral processing activities also release lead to the atmosphere. The mine's Air Quality Control System minimises the exposure of residents to this air-borne lead by progressively shutting down the smelters when adverse meteorological conditions are predicted. In addition to the naturally occurring lead in soil, lead in dust generated by the smelter and associated mineral processing activities has the potential to deposit in the community.

The Mount Isa community has had a long history in working together with industry to reduce the potential for community lead exposure. In 1992, Mount Isa Mines (MIM) Limited organised a voluntary blood lead sampling program focused on young children. This was an 'opportunistic' program, designed to measure blood lead levels in children when children needed blood tests for other purposes. The results of this study for the period 1992–1994 indicated that 101 children in the one to four year age range were tested. The mean blood lead level of these results was 10.9 µg/dL (SD 6.1 µg/dL), range 2 -29 µg/dL. Of the initial samples 15.6% of the children had blood lead levels exceeding 15 µg/dL and 36.7% had levels exceeding 10 µg/dL. As these results are not based on

a random sample of young children in Mount Isa, it can be argued that they do not reflect typical blood lead levels of young children in Mount Isa (Mount Isa Community Blood Lead Data, 1994).

Prompted by the results of this program, the Community Environmental Health Committee was formed in 1994. Its membership included Mount Isa City Council, MIM Ltd, representatives from community, health and medical organisations from the community, and other representatives from relevant state government departments, including Queensland Health. Its charter was to manage activities aimed at reducing the impact of lead contamination and to provide comprehensive and effective lead education for the community. This committee existed until the late 1990s when its activities and blood lead results were compiled into a final report by Mount Isa City Council.

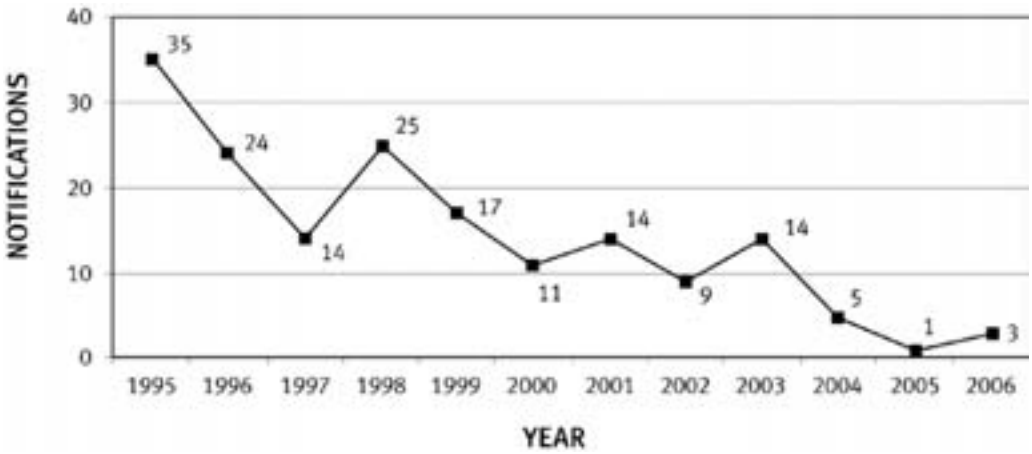
Following this work, ongoing lead education and awareness activities have been coordinated by the Mount Isa City Council. These activities include Lead Awareness Week, lead education at community events and schools, and the provision of information to the community. Educational material included brochures on Lead and Your Family's Health, Lead and Pregnancy, Lead and Nutrition, Lead and Home Cleaning, Lead and Your Backyard, and Lead and Home Renovations.

In order to respond strategically and effectively to community concerns and the results obtained in this 2008 report, a new group of key partners was formed early in 2008. This new group is called the 'Living with Lead Alliance'. The group is governed by an Executive Committee and supported by a Working Group. Representatives on these groups include the Mount Isa Mayor, the Member for Mount Isa, Queensland Health and Environmental Protection Agency staff (including local officers), Xstrata Copper staff, a senior medical practitioner from the Mount Isa community and a local Indigenous leader. The role of the alliance is to provide a forum for guiding and driving action on the issue of lead in the community of Mount Isa. It is intended that information on Terms of Reference, membership, minutes of meetings and other relevant information will be placed on the internet once a website is established.

2.0 Study rationale

Through its notification system, Queensland Health can monitor the number of notified cases of elevated blood lead levels relating to occupational and non-occupational exposures. The most recently published report (QH, 2006) shows the continued decline in lead notifications in children (0-4years) in Queensland since 1995 (refer to Figure 2.1) and the plateauing of the median blood lead level reported in 2005 and 2006.

Figure 2.1: Notifiable Blood Lead Levels in Queensland Notifications for Children (0 to 4 years)



Source: Queensland Health (2007)

Since 1995 there has been a noticeable decline in the number of notifications of elevated blood lead levels received for the Mount Isa community from 20 cases per year to less than two cases per year since 2001. Of these notifications none had been for children aged 16 years or younger. For Queensland as a whole, Queensland Health does not receive data about the total number of people tested for lead in their blood. It is therefore difficult to determine whether the reduction in notifications is due to a decrease of blood lead levels in the community or whether there has been a decrease in testing for blood lead. Between 1998 and 2005, 501 blood samples had been analysed for children under 16 in Mount Isa and none of these exceeded the level of 15 µg/dL required for notification. According to the 2006 annual notification report, two Mount Isa children had a notifiable blood lead level in that year (Queensland Health, 2007).

Though the notification system can provide some insight into lead exposure in the general community, it relies on individuals requesting blood lead analysis by a health professional or on request of a health professional following a consultation. Therefore, unless an individual or their doctor suspects that lead may be contributing to illness and wellbeing, blood lead levels are not routinely monitored.

Following interest and concern expressed by the community in early 2006, the Environmental Health Service of Population Health in Queensland Health convened a meeting of key partners to scope a project proposal that would provide robust and epidemiologically sound data to identify whether there was a community lead problem in Mount Isa.

3.0 Study aims

The primary aim of the study was to determine the blood lead levels of a representative number of children from the Mount Isa community with a view to identifying children who had elevated blood lead levels, and then working with the families of these children to reduce their blood lead level.

The study objectives were for Queensland Health to:

- measure the blood lead levels in children from a representative sample of children in the Mount Isa community
- identify risk factors for lead exposure in children with blood lead levels over the health goal level of 10 µg/dL
- assist affected families in reducing their lead exposures through advice and information
- expand on the existing evidence-base to assist further action to manage lead exposure in the Mount Isa community.

4.0 Study methods

4.1 BLOOD LEAD SAMPLING

A sample size of 400 (approximately 25% of the Mount Isa population of children aged one to four) was determined to have sufficient power to provide reliable information on blood lead levels that were representative of the targeted population. Children were eligible to participate if they were between one and four years of age and resided in Mount Isa. Children aged one to four years were chosen as the target group due to their potentially higher exposures from their hand-to-mouth activity and the weight of evidence that identifies important health effects from lead for this age group and their general vulnerability. Carrying out a study that targeted children provided Queensland Health with an opportunity to identify and work with the families of young children at risk of important developmental health effects from lead exposure – by intervening at such a critical stage of development, long-term population health benefits can be realised.

Children were not randomly selected but were invited to participate and therefore were 'self-selected'. However, recruiters ensured that the age, sex and indigenous distribution of the sample population was equivalent to the age, sex and indigenous distribution of the Mount Isa population aged one to four based on the 2006 Census (Australian Bureau of Statistics 2006b). There was no statistically significant difference between the sample population and the Mount Isa population for the distributions for age, sex and Indigenous status.

Table 1: Demographic characteristics of the sample population and the Mount Isa population aged one to four years.

	Sample population		Mount Isa Population	
Indigenous status	**Number (n=400)**	**Percentage of population**	**Number (n=1485)**	**Percentage of population**
Indigenous	83	20.1	396	26.7
Non Indigenous	315	78.8	1089	73.3
Sex				
Male	214	53.5	769	51.8
Female	184	46.0	716	48.2
Age				
12-23 months (1 year)	84	21.0	387	26.1
24-35 months (2 years)	114	28.5	374	25.2
36-47 months (3 years)	106	26.5	390	26.3
48-59 months (4 years)	95	23.8	334	22.5

** Please note that numbers and percentages in the sample population do not add up to 400 or 100% due to missing data items*

Blood sampling from venepuncture is considered to be the most reliable method for blood lead testing and this was the method used for blood collection for analysis. As blood testing this way is invasive, children less than one year of age were not included.

Children were recruited into the study by invitation through an extensive print media campaign ('Get Bled for Lead'), with specific targeting of childcare centres and other community education activities at shopping centres and fun days (refer to Appendix 1 for examples of material used).

The 'Get Bled for Lead' campaign served two purposes – it provided awareness and information on how to participate in the study and also provided information to the community on how to reduce their lead exposure. As part of the study, regular updates were provided to the community on the study progress. For example, regular newspaper articles included information on the number of children tested, the number with elevated levels, reminders about where testing could be done and some tips on how to reduce lead exposure. Specialist education on lead toxicity in children was also provided to Mount Isa medical practitioners.

Blood sampling occurred at either Queensland Medical Laboratory pathology services or Queensland Health Pathology services. To supplement these pathways, trained staff also provided after-hours opportunities for sampling at several day/childcare centres and at numerous community fun days and events. Another recruitment method used was opportunistic testing when blood was collected for other purposes.

Informed written consent was obtained from all parents or guardians prior to blood testing. At the time of blood testing information on age, sex, Indigenous status and length of time lived in Mount Isa was recorded.

The blood lead analysis was done by either Queensland Health Scientific Services or Queensland Medical Laboratories (QML), depending on where the test was taken. The lowest level of detection for blood lead levels for the QML analysis method was 0.10 µmol/L (which when converted equates to 2.1 µg/dL). This means that the analytical method could not measure with accuracy below 2.1 µg/dL. For the purposes of statistical analysis, all data reported as <2.1 µg/dL was treated as 2 µg/dL. Queensland Health Scientific Services used a slightly different analytical method and was able to measure with accuracy as low as 0.05 µmol/L (which when converted equates to approximately 1 µg/dL). However, no blood lead levels in this study were found to be as low as this reporting limit.

To determine appropriate follow up for blood lead level results, Queensland Health used the blood lead management criteria as recommended by the American Academy of Paediatrics (2005). Parents/guardians were advised of the results by a public health nurse approximately a week after testing. The nurse described what the results meant and provided any further information if requested. At this time, the nurse also advised the parent/guardian of children with blood lead levels over 10 µg/dL that they would be contacted by Environmental Health staff to discuss how lead exposures could be minimized and to request a survey of their home environment. Results were also forwarded to a nominated family General Practitioner, if requested.

Blood testing commenced on 18 September 2006 and continued until 8 December 2007, at which time a total of 400 children had been tested for their blood lead level. This represented a total of 334 geographical locations, as testing was carried out for more than one child in 66 households.

4.2 HOUSEHOLD AUDIT

A household audit was undertaken for those children identified as having blood lead levels at or over 10 µg/dL. Health authorities such as the US CDC (2007) and WHO (2007) consider this a level at which prevention activities should be initiated. The primary purpose of the household audit was to assist Queensland Health to identify household factors that may be influencing the blood lead levels for those in the elevated group for this study. As audits were not conducted for all households in the study, the data is not useful for drawing general conclusions about common risk factors for blood lead levels in Mount Isa.

Households were generally visited within two weeks following notification of blood lead results. Household surveys were undertaken by one or two Queensland Health environmental health officers when a parent/guardian was home, following verbal consent being obtained from the child's parent or guardian. While at the child's home, the officer discussed the child's blood lead level with the parent/guardian, conducted the survey using observation and asking questions of the parent/guardian, and took soil samples or paint samples on the basis of responses to the survey questions.

The survey tool consisted of four parts including:

- general details of the household
- child behaviour (e.g. time at address, thumb sucking etc)
- occupant information (e.g. occupations of residents, hobbies)
- home environment (e.g. exterior, interior, pets and food growing).

The survey questions were based on risk factors for lead exposure reported in the literature. A copy of the audit tool is included as Appendix Two.

Surveys were undertaken by a number of different environmental health officers. To ensure as much consistency as possible, an audit guideline was developed and procedure for undertaking audits was discussed with all environmental health officers prior to commencing the audit program.

A total of 43 audits were completed on the basis of the initial blood lead data. Additional audits were conducted if children spent significant times in other environments. Where siblings with elevated leads were in the same residence, only one audit was conducted. Eighty-three soil samples were also collected from external areas (including sand pits, vegetable gardens and other bare soil areas) of 42 households and one childcare centre. Paint samples were taken from four households, and 31 dust samples were taken from 19 households. All samples were collected using standard methods and analysed by Queensland Health Scientific Services. The results assisted Environmental Health Services in identifying potential exposures and targeting personal strategies to minimise risk.

4.3 DATA ANALYSIS

Data analysis was undertaken using Stata version 9 (StataCorp LP, College Station, Texas, USA). Maps were produced using MapInfo Professional version 8 (Pitney Bowes, New York, USA).

Blood lead levels were calculated as a categorical variable for logistic regression analyses for the elevated blood lead group (BLL $\geq$10). The variables sex, indigenous status, age in months and time resident (both as continuous variables) in Mount Isa were included in the models. Both age in months and time resident in Mount Isa were normally distributed. Fractional polynomial tests were performed to ensure they could be used untransformed in the logistic regression analysis.

A relationship was considered to be statistically significant if $p<0.05$, i.e. the probability incorrectly rejecting the null hypothesis (stating that there is a relationship when in fact there is none) is less than 5%. All proportions and means were calculated ignoring missing values.

5.0 Study results

5.1 PARTICIPANT CHARACTERISTICS

Table 2 provides a summary of the ages of the children who participated in the study as well as the time they had spent in Mount Isa. The table includes a breakdown by their sex and Indigenous status. The mean age of the sample population was 36 months, 20% were Indigenous and 54% were male. The average length of time that children had resided in Mount Isa was two years and four months.

Table 2: Description of the study samples' age, sex, Indigenous status and time spent in Mount Isa.

	Number	Mean age in months (standard deviation)	Min – Max values
Age (months)			
• All	399	36.1 (13.1)	12-59
• Male	214	36.9 (13.4)	12-59
• Female	183†	35.3 (12.8)	12-59
• Indigenous	82†	37.1 (13. 6)	12-59
• Non-Indigenous	315	35.8 (13.0)	12-59
Months in Mount Isa			
• All	386	28.1 (14.2)	1-60
• Male	210	28.4 (14.8)	1-60
• Female	174	27.8 (13.4)	2-57
• Indigenous	77	32.4 (13.3)	2-59
• Non-Indigenous	309	27.0 (14.3)	1-60

** Please note that numbers do not total 400 due to missing values from the consent forms*
† Female, Indigenous person with age not recorded

Figure 1 (page 23) illustrates where children who participated in the study lived at the time of their blood test. In addition to households where one child was tested, the map also shows the number of households where more than one child (generally a sibling) was tested.

5.2 BLOOD LEAD LEVELS FOR PARTICIPATING MOUNT ISA CHILDREN

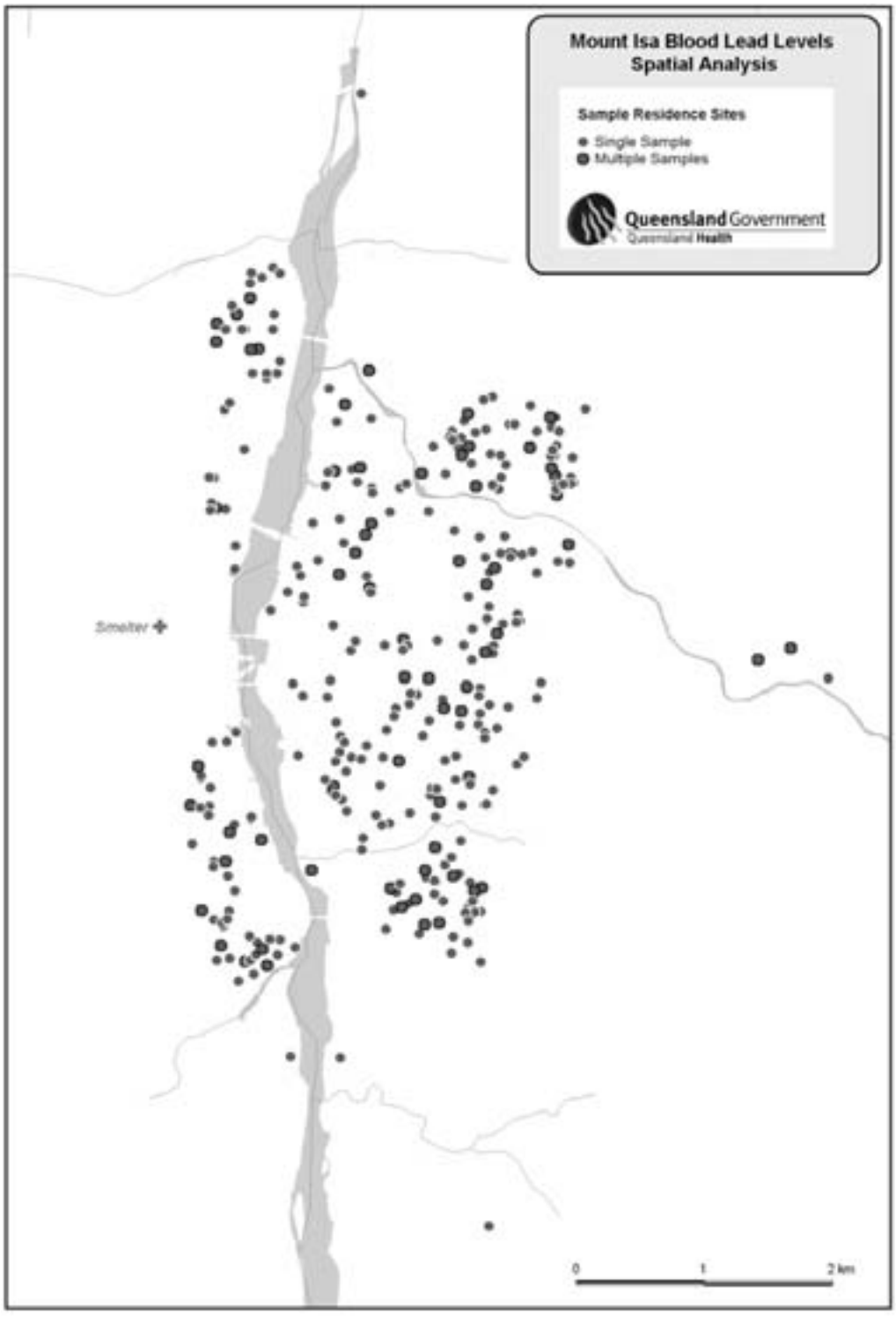
Table 3 shows the geometric mean blood lead levels for the study group with breakdowns by sex and Indigenous status. The geometric mean for the entire group was 5.0 µg/dL (with a minimum value of 1.3 µg/dL and maximum value of 31.5 µg/dL). The geometric mean blood lead for boys was 5.1 µg/dL compared to 4.8 µg/dL for girls. The geometric mean blood lead for Indigenous children was 7.0 µg/dL compared to 4.5 µg/dL for non-Indigenous children.

Table 3: Summary of geometric mean blood lead levels by sex and Indigenous status

	No.	Geometric mean blood lead level (95% confidence intervals)	Min – Max values
Blood lead (µg/dL)			
• All	400	5.0 (4.7, 5.2)	1.3-31.5
• Male	214	5.1 (4.8, 5.5)	1.9-31.5
• Female	184	4.8 (4.4, 5.2)	1.3-18.0
• Indigenous	83	7.0 (6.2, 8.0)	1.3-31.5
• Non-Indigenous	315	4.5 (4.3, 4.8)	1.5-22.7

** Please note that numbers do not total 400 due to missing values from the consent forms*

Figure 1: Study participants' home locations at the time of blood testing.



Of the 400 children who had blood lead level tests, 11.3% (45 children) had blood lead levels greater than or equal to 10 µg/dL. Of these, only two had levels above 20 µg/dL (this is the level at which children were referred to a paediatrician for examination and assistance with factors such as diet). The distribution of blood lead levels is shown in Figure 2.

Figure 2: Distribution of blood lead levels (µg/dL) for the study group.

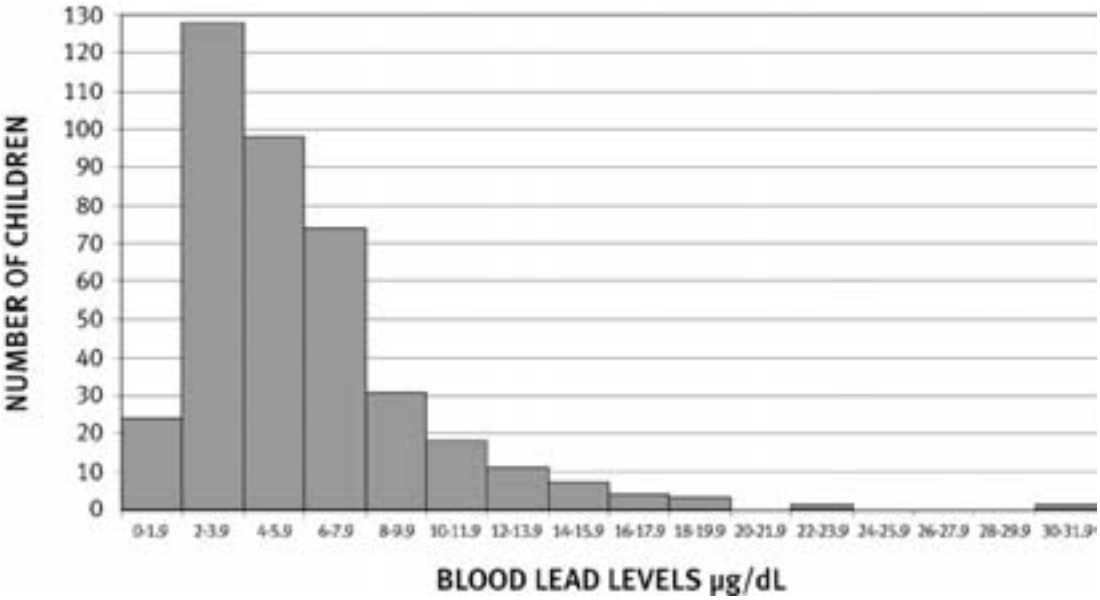


Figure 3 (page 25) shows the domestic locations of children in the study with blood lead levels of less than 10 µg/dL and equal to or greater than 10 µg/dL.

Table 4 (page 26) lists the prevalence of high blood lead ≥10 µg/dL by Indigenous status and sex.

Figure 4 (page 27) illustrates the spatial distribution of blood lead levels in the Indigenous population of children from the study.

Figure 3: Distribution of children with blood lead levels less than 10 µg/dL and those with blood lead levels equal to, or greater than 10 µg/dL.

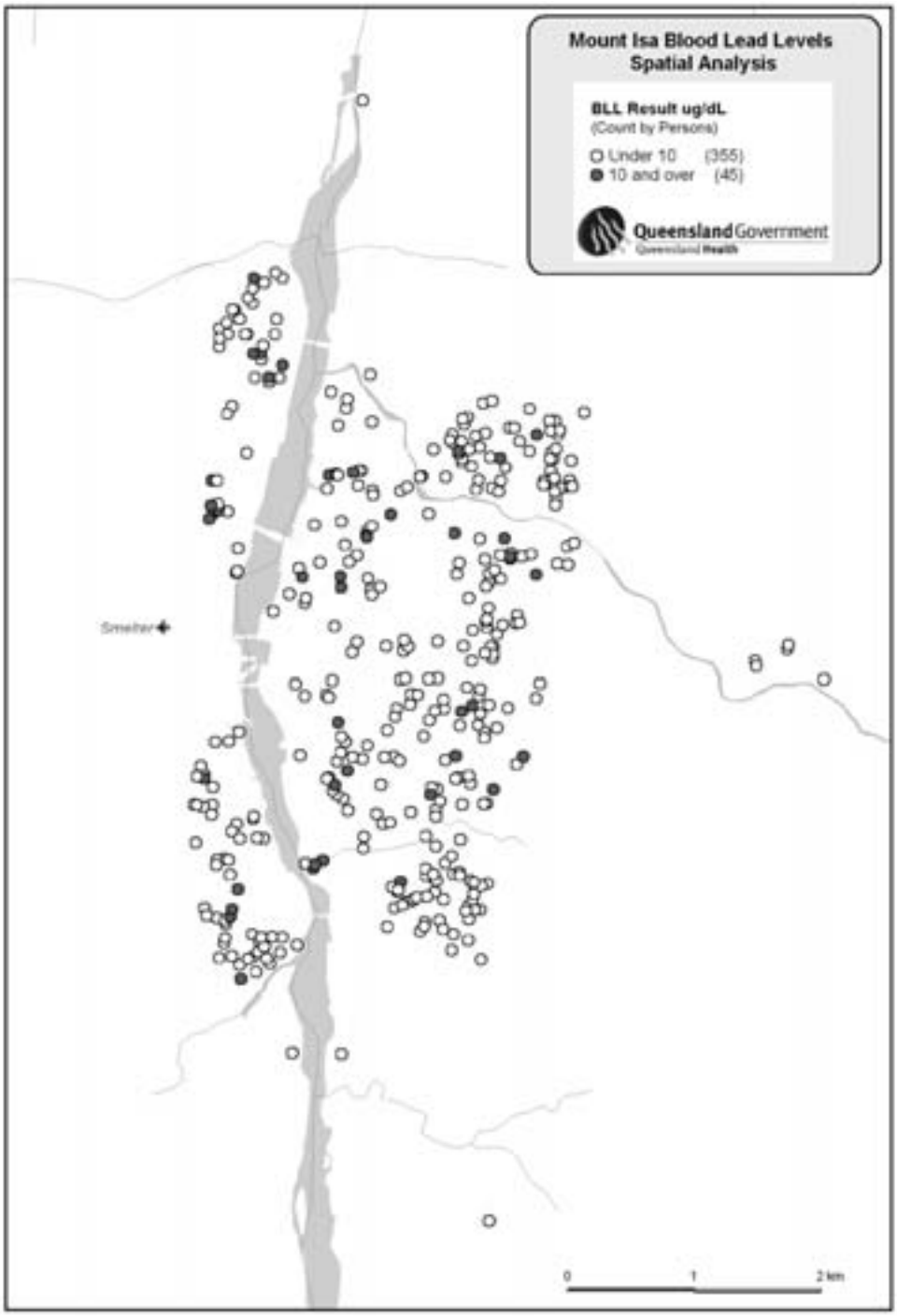


Table 4: Prevalence of high blood lead ≥10 µg/dL by Indigenous status and sex

	Blood lead levels (BLL) ≥10 µg/dL n=45
Indigenous status	
Indigenous	22 (26.5%)*
Non-Indigenous	23 (7.3%)
Sex	
Male	26 (12.1%)
Female	18 (9.8%)

** Percentage relates to the proportion of the study population with elevated blood lead levels.*

Please note that numbers for Sex do not total 45 due to missing values from the consent forms.

Figure 4: The distribution of blood lead levels for the Indigenous and non-indigenous children who participated in the study

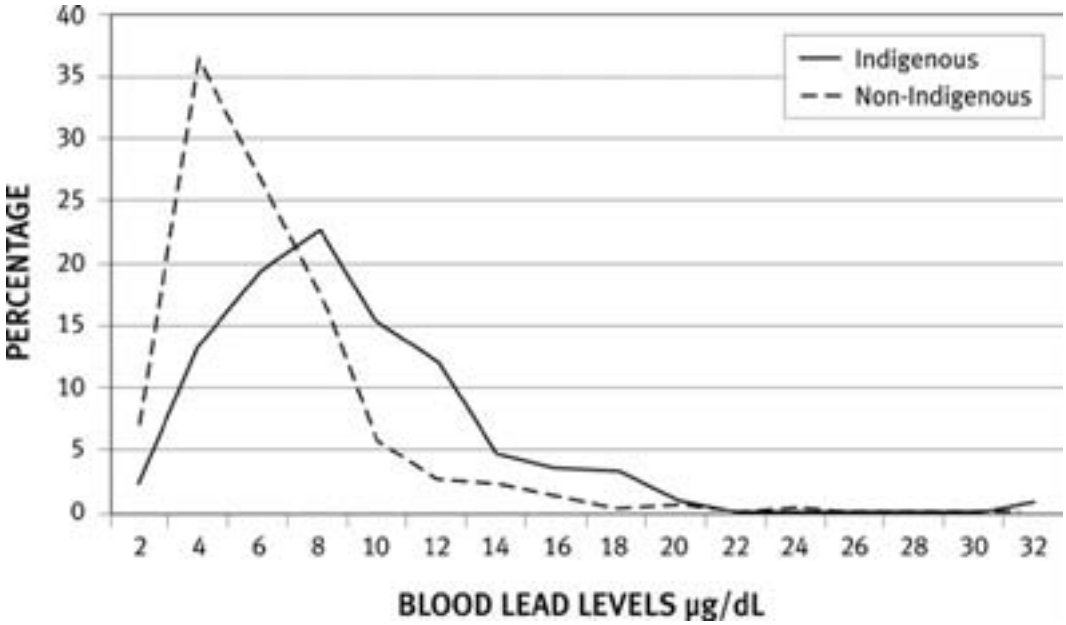
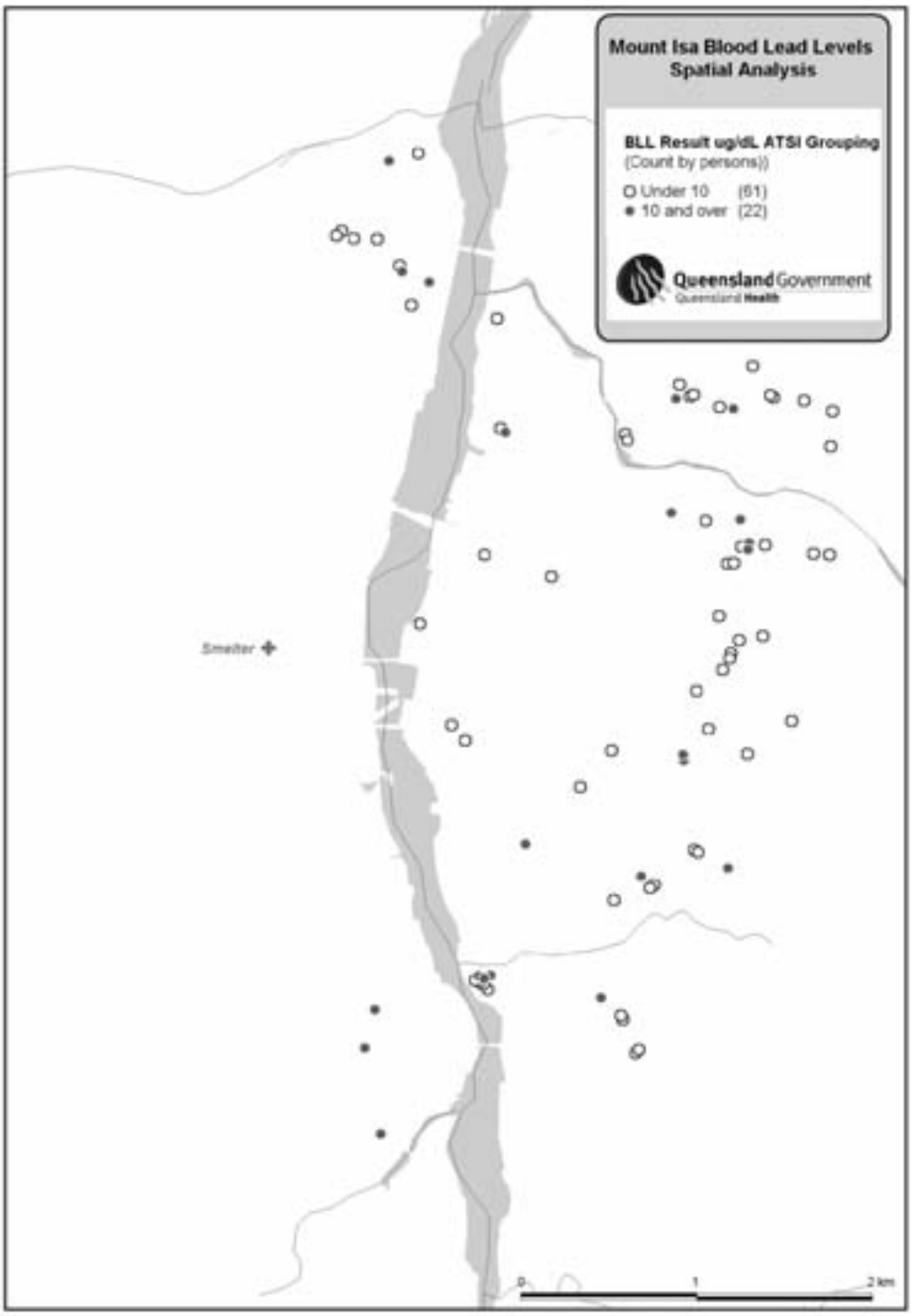


Figure 5: Distribution of Indigenous children with blood lead levels less than 10 µg/dL and those with blood lead levels equal to, or greater than 10 µg/dL.



Logistic regression analyses revealed significant associations between blood lead levels greater than or equal to 10 µg/dL and Indigenous status and age (Table 5). There were no statistically significant associations between high blood lead levels and the variables of sex or time in Mount Isa. Output for this statistical analysis can be found in Appendix 3.1.

Indigenous children were approximately four times more likely to have a blood lead level of greater than or equal to 10 µg/dL than non-Indigenous children (Table 5). With every one month increase in age, children were 4% less likely to have a blood lead level of greater than or equal to 10 µg/dL (Table 5).

Table 5: Odds ratios and 95% Confidence Intervals calculated from logistic regression model

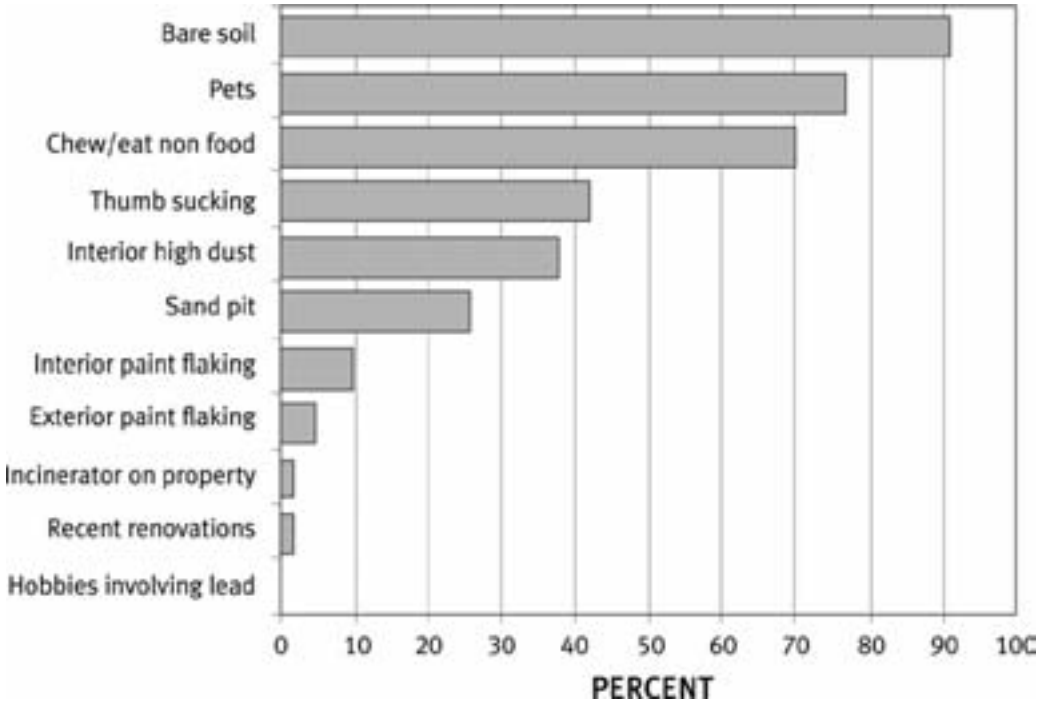
Variable	Odds ratio (95% confidence intervals)	P value
Age at test (months)	0.96 (0.92, 0.99)	0.022
Indigenous status	4.34 (2.20, 8.57)	<0.000
Sex	1.39 (0.71, 2.73)	0.337
Time in Mount Isa (months)	1.03 (0.99, 1.07)	0.159

5.3 HOUSEHOLD FACTORS

The homes of children with a blood lead level greater than or equal to 10 µg/dL (n=45) were audited to identify potential risk factors for elevated blood lead levels in children. Figure 5 shows the occurrence of some of the key risk factors for those children whose blood lead levels were over 10 µg/dL. Behaviours or other factors potentially influencing lead exposures that were common within this elevated blood lead group were: chewing/eating non food, residing in a property with bare soil and pet ownership. For those properties with bare soil the mean percentage of bare soil was 20%, with a minimum of 5% and maximum of 80%.

As indicated by the environmental audit (provided in Appendix 2), additional variables were measured in the audit. However they have not been included in this report as they were collected for the purposes of individual follow up and intervention.

Figure 6: The most frequent risk factors for lead exposure identified for those children with blood lead levels greater than or equal to 10 µg/dL.



6.0 Discussion

Figure 1 (page 23) shows the locations of all the children who provided blood lead samples for this study. The map shows that individuals who participated in the study were evenly distributed across the Mount Isa community.

The geometric mean for the entire study group was 5 µg/dL, with a maximum of 31.5 µg/dL. This is very similar to the results of the 1995 Australian survey where the geometric mean reported was 5.05 µg/dL (5.59 µg/dL in Queensland), with a maximum of 32.7 µg/dL (Donovan, 1996). Findings from the 1995 study of blood lead levels in children from representative areas across all of Australia reflected the historical use of lead in petrol and its impacts on general exposure to lead in the community.

In this study, 45 children (11.3% of those in the study group) had blood lead levels greater than or equal to 10 µg/dL. Of these, two children had blood lead levels greater than 20 µg/dL. These two children were referred to a paediatrician for additional examination and discussion of measures to reduce blood lead levels. There is evidence to suggest a non-threshold relationship between increases in blood lead level in children and reductions in indicators of learning development such as IQ, meaning that efforts should be made to reduce lead exposure in children.

Statistically significant factors found to influence blood lead levels of children in the study group were age and Indigenous status. Both of these statistical relationships are consistent with those found in the 1995 Australian study (Donovan, 2006). Age is a common influence and relates to general play activity (e.g. play in soil and sand, and with pets) and associated hand-mouth activity associated with such play, as well as dietary factors associated with inadequate intake of calcium and iron. Those Indigenous children in the study had a much higher chance of having elevated blood lead levels. This points to the need for further examination of exposure factors such as playing in soil and with pets with associated hand-mouth activity, and predisposing dietary factors in these children.

Figure 2 (page 24) shows that for this sample, there are no distinct spatial patterns of blood lead levels within the Mount Isa township. This is consistent with the literature that indicates that individual behaviours and household factors are the most important influence on blood lead levels in children. A preliminary analysis of such risk factors reveals that important contributing factors to the elevated lead levels in this study group are chewing and mouthing behaviour, presence of bare soil in the house yard, ownership and playing with pets (in particular dogs).

For this group, the priority for Queensland Health has been to work with the families to identify and then modify any risk factors thought to relate to lead exposure and absorption in children. For some children who were identified earlier in the study, blood lead retesting has indicated that modifying risk factors (such as monitoring child hand-to-mouth behaviour and reducing access to bare soil in house surroundings) has reduced blood lead levels.

Though the magnitude of health effects of blood lead levels of < 10 µg/dL are not clear, there is increasing evidence that there is no threshold for developmental effects of lead exposure. In recognition of this, the Mount Isa community need to continue to work together to reduce lead exposure as much as possible. Queensland Health recognises the importance of this and is continuing to promote health messages through broader, population-based strategies of education and improved parental and child awareness of how to live safely with lead.

7.0 Queensland Health response

Queensland Health has been actively monitoring the results of the study to make sure that follow-up investigation and education was carried out for those households where it was considered necessary. Around four months into the study, an interim analysis was also undertaken to provide some information on trends. This interim analysis led to a number of actions such as increased community education, which included the development and circulation of fact sheets and posters and targeted stories in local community publications and newspapers (refer to Appendix 1).

For those households where children had elevated blood lead levels, individual follow-up activities have focused on:

- additional audits or collection of soil/paint/dust samples at other places where the child spends time
- assistance with modifying the home environment, and improving awareness regarding child hand-mouth behaviours and practices
- dietary investigation and advice
- additional blood testing to determine if exposure prevention strategies are reducing blood levels.

In order to maximise the efficiency and effectiveness of Queensland Health's health promotion strategies relating to lead, a research company will be commissioned in 2008 to undertake focus-group testing of Mount Isa parents to better determine current attitudes and beliefs about lead risks and protective factors.

Queensland Health continues to encourage community uptake of the free blood lead testing service at Queensland Medical Laboratory Pathology Services and will closely monitor results of any testing done. In addition, Queensland Health will continue to work with key partners through the Living with Lead Alliance to develop long-term strategies for lead management in Mount Isa.

8.0 Recommendations

1. Queensland Health will continue to monitor the results of routinely collected blood lead levels in Mount Isa, and actively manage elevated blood lead levels at 10 micrograms per decilitre and above.

2. Queensland Health will undertake a follow-up study of the blood lead levels of children in Mount Isa in 2012.

3. Queensland Health will continue to promote health messages through education and improved parental and child awareness of how to live safely with lead.

4. Queensland Health will continue to work with the Living with Lead Alliance. This work will include the development of more comprehensive mitigation strategies, including dust-control measures.

9.0 References

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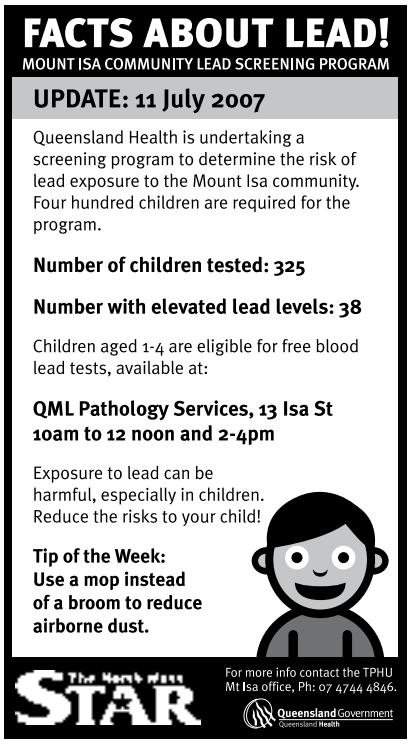
Appendix 1

EXAMPLES OF MATERIAL USED IN THE 'GET BLED FOR LEAD' CAMPAIGN



Appendix 2

ENVIRONMENTAL AUDIT TOOL USED FOR THE STUDY

ENVIRONMENTAL AUDIT TOOL			
Officer:		**Inspection Date:**	
Population Health Unit:	**Townsville**	**Time:**	

1.0 DETAILS		
1.1 Name	Surname:	Given Names:
1.2 Date of Birth		Male Female
1.3 Residential address		
1.4 Guardian/Parents Name	Surname:	Given Names:
	Relationship with child:	
	Surname:	Given Names:
	Relationship with child:	
1.5 Telephone number	Home:	Mobile:

2.0 CHILD	
2.1 Does the child suck their thumb?	☐ Yes ☐ No ☐ Sometimes
2.2 Does the child mouth, chew or eat non-food items?	☐ Yes ☐ No ☐ Sometimes
2.3 Are the toys, blankets and dummies cleaned regularly?	☐ Yes ☐ No How often?
2.4 Does the child eat regular nutritional meals and snacks?	☐ Yes ☐ No ☐ Sometimes
2.5 Does the child have any favourite places to play?	☐ Yes ☐ No How often?
2.6 How long has the child been living at this address?	
2.6.1 Previous address	
2.7 Does the child regularly visit another home/place?	☐ Yes ☐ No

2.7.1 Associated address(s)	
3.0 OCCUPANTS	
3.1 What are the occupations of the residents? (abrasive blasters, mechanic, construction workers, landscapers, painters)	1
	2
***Note name & relationship with child**	3
3.1.1 If a resident is exposed to lead in their occupation, do they return home without showering?	☐ Yes ☐ No ☐ Sometimes
3.1.2 If so, where are dirty work clothes stored?	
3.1.3 Is the washing machine water reused on the garden?	☐ Yes ☐ No Where?
3.1.4 Are contaminated work tools, boots or vehicles brought home?	☐ Yes ☐ No ☐ Sometimes
3.2 Do residents engage in hobbies involving lead at home? (eg car/boat building, antique restoration, casting lead fishing sinkers)	☐ Yes ☐ No Details:
3.2.1 If so, does the child play in this area or with any associated equipment?	☐ Yes ☐ No ☐ Sometimes
3.3 Do residents use any alternative medicines, herbal preparations, tonics or traditional cosmetics?	☐ Yes ☐ No Details:

Comments

4.0 HOME ENVIRONMENT	
4.1 EXTERIOR	
4.1.1 Is there a sand pit near the home?	☐ Yes ☐ No Details:
4.1.2 Are there areas of bare soil in the yard?	☐ Yes ☐ No Percentage: Details:
4.1.3 Was the land ever used for industrial purposes?	☐ Yes ☐ No ☐ Unsure
4.1.4 Has fill been brought to the property?	☐ Yes ☐ No ☐ Unsure
4.2 INTERIOR	
4.2.1 Do interior surfaces have a high level of surface dust?	☐ Yes ☐ No Description of floor surface material:
4.2.2 Has any interior construction been undertaken in the recent past?	☐ Yes ☐ No ☐ Unsure
4.3 PAINT	
4.3.1 How old is the dwelling?	☐ Unsure
4.3.2 What is the condition of the paintwork? (including sheds)	Exterior ☐ Good ☐ Flaking ☐ Not painted/other Interior ☐ Good ☐ Flaking ☐ Not painted/other
4.3.3 Has the home/furniture recently been renovated, paint stripped or disturbed?	☐ Yes ☐ No ☐ Unsure Details:

4.3.4 Have any neighbouring properties recently been renovated, paint stripped or disturbed?	☐ Yes ☐ No ☐ Unsure Details:
4.3.5 Does the property or near by properties use an incinerator?	☐ Yes ☐ No Details:
4.4 PETS	
4.4.1 Are there pets?	☐ Yes ☐ No Details:
4.4.2 Are the pets allowed indoors?	☐ Yes ☐ No
4.4.3 Are the pets and bedding regularly washed?	☐ Yes ☐ No How Often:
4.4.4 Does the child play with the pets?	☐ Yes ☐ No
4.5 Food	
4.5.1 Are homegrown fruit and vegetables washed before being eaten?	☐ Yes ☐ No ☐ Sometimes
4.5.2 Is water, other than the reticulated system, used for drinking?	☐ Yes ☐ No ☐ Sometimes

Comments

Appendix 2 (cont.)

5.0 POSSIBLE RISKS IDENTIFIED	
Concern	**Action**
2.0 CHILD	
3.0 OCCUPANTS	

Appendix 2 (cont.)

4.0 HOME ENVIRONMENT	

MAP OF PROPERTY

DETAILS OF SAMPLES TAKEN (ALSO INDICATE ON MAP)

1

2

3

4

OFFICER SIGNATURE: DATE:

Appendix 3

STATISTICAL ANALYSIS RESULTS

3.1 Regression models – raw output

Logistic regression — Number of obs = 383

LR chi2(4) = 25.10

Prob > chi2 = 0.0000

Log likelihood = -121.97477 — Pseudo R2 = 0.0933

ten	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ageattest	.9570877	.018376	-2.28	0.022	.9217407	.9937902
indig	4.336822	1.506442	4.22	0.000	2.195319	8.567333
sex	1.391797	.4793296	0.96	0.337	.708639	2.733546
timeinmtis~s	1.026657	.019154	1.41	0.159	.9897935	1.064893

3.2 The percentage of children/households with elevated blood lead levels (ie. > 10 µg/dL) with common factors known to increase the potential for elevated blood lead levels

Factor	Percentage of households/ behaviours identified
Thumb sucking	42%
Chew/eat non food	70%
Sand pit	26%
Bare soil	91%
Interior high dust	38%
Exterior paint flaking	5%
Interior paint flaking	10%
Recent renovations	2%
Incinerator on property	2%
Hobbies involving lead	0%
Pets	77%
• Of those with pets - dogs	88%
• Pets allowed indoors	52%
• Children play with pets	79%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