nsw cdrt child death review team

Spatial analysis of child deaths in New South Wales

Prepared by the Australian Institute of Health and Welfare for
the NSW Child Death Review Team

A report under section 34H
Community Services (Complaints, Reviews and Monitoring) Act 1993

April 2018

NSW Ombudsman
Level 24, 580 George Street
Sydney NSW 2000

Phone 02 9286 1000
Toll free (outside Sydney Metro Area): 1800 451 524
Facsimile: 02 9283 2911
National Relay Service: 133 677
Website: www.ombo.nsw.gov.au
Email nswombo@ombo.nsw.gov.au

ISBN: 978-1-925569-79-7

Contents

Acknowledgments

This report was prepared by Deanna Pagnini, Mark Walker, Hayden Stevens, Jeanine Willson, and Martin Edvardsson from the Indigenous Spatial Analysis and Health Services Unit of the Indigenous and Maternal Health Group at the Australian Institute of Health and Welfare. Thanks are extended to Fadwa Al-Yaman and Leo Carroll for their helpful guidance and feedback throughout the project.

The work was commissioned by the New South Wales Child Death Review Team, who also supplied the child deaths data. AIHW gratefully acknowledges the valuable support of Monica Wolf and the staff of the Child Death Review Team at the NSW Ombudsman's Office, and the members of the Child Death Review Team for their contributions and comments throughout the project.

Abbreviations

ABS	Australian Bureau of Statistics
AEDC	Australian Early Development Census
AIHW	Australian Institute of Health and Welfare
ASGS	Australian Statistical Geography Standard
CDRT	Child Death Review Team
CS CRAMA	*Community Services (Complaints, Reviews and Monitoring) Act 1993* (NSW)
ERP	estimated resident population
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, tenth revision, Australian Modification
IRSD	Index of Relative Socio-Economic Disadvantage
LGA	local government area
LHD	local health district
NSW	New South Wales
PHN	primary health network
SA	statistical area
SEIFA	Socio-Economic Indexes for Areas
SIDS	sudden infant death syndrome
SUDI	sudden unexpected death in infancy
vs	versus

Symbols

<	less than
%	per cent
+	plus

Foreword

The NSW Child Death Review Team (CDRT) works to prevent and reduce the deaths of children aged from birth to 17 years. To do this, we maintain a register of child deaths occurring in NSW and analyse information about these deaths to identify any patterns or trends. One pattern we need to understand is the geographic distribution of child deaths in NSW, and how this may vary by cause of death and the characteristics of geographic areas.

In 2016, we engaged the Australian Institute of Health and Welfare to undertake geospatial analyses of the 8,657 deaths of children that occurred in NSW between 2001 and 2015. This report details the findings of that work.

The report finds that overall, the child mortality rate in NSW has been in decline. Across the nearly 90 geographic areas analysed, the report finds that no area in NSW saw a significant increase in its child mortality rate over the period examined, and there was a significant decline in 18 areas. Additionally, the differences in mortality rates between areas has narrowed over time. These are reassuring findings confirming that the number and rate of child deaths is being reduced throughout NSW.

That said, some areas have experienced higher actual numbers of infant and child deaths than others, or higher mortality rates, or both. These differences are described in the report.

The analysis also examines variations in child mortality by area level characteristics. It is sobering that the analysis enumerates the increased likelihood of a child dying in our state if they live in a disadvantaged area, and specifically, if they live in an area characterized by high poverty, low school engagement, overcrowded housing and childhood developmental vulnerability.

The report is a statistical analysis and does not purport to answer the many questions it raises. It is important information from a policy perspective, because it can assist with targeting place-based programs and interventions. We hope that government as a whole, and individual areas through local government and area-based service systems, will closely examine the report in this context. As custodians of the Child Death Register, we also have an important role to play in collaborating with agencies to ensure the information we hold can inform strategies to prevent the deaths of children.

Michael Barnes
NSW Ombudsman

Summary

Identifying geographic areas with high numbers of child deaths and child mortality rates can provide opportunities for targeted interventions. To this end, the New South Wales Child Death Review Team (CDRT) engaged the Australian Institute of Health and Welfare (AIHW) in 2016 to undertake a series of geospatial analyses using the CDRT's child deaths data. This report presents the findings from that project. It focuses on two key issues—the geographic distribution of child deaths across New South Wales, and how the risk of child death varies by area-level characteristics.

Data and methods

The project used individual-level data from the CDRT's database on the 8,657 children who died in New South Wales between 2001 and 2015, were residents of the state when they died, and whose home addresses could be geocoded. These data were then aggregated to the Statistical Area (SA) 3[1] level to examine area-level numbers of child deaths and child mortality rates.

Counts and rates—what do they tell us?

Counts of deaths and child mortality rates are both useful area-level indicators:

- Counts are the aggregated number of deaths in a particular area. They can be computed by cause, age group or population group. They are useful for identifying areas where location-based interventions or risk reduction strategies could be helpful. However, counts cannot be used to compare the risk of death across areas because the number of deaths in an area may be high simply because there are larger numbers of children in that area compared with others.
- Mortality rates (the number of deaths per 100,000 population) are a measure of the risk of dying. They are useful for comparing the risk of dying across geographic areas or across particular causes of death, population groups and across time. However, it is important to note that even if an area has a high mortality rate, the actual number of deaths in that area may be low.

The data were divided into three time periods, with more detailed information presented on causes of death for children aged 0–17 (2011–2015) and infants (2010–2014). A series of SA2 and SA3 level contextual variables in 4 domains (economic context, social capital, housing and child development) was attached to the records to enable child mortality rates across key indicators of advantage and disadvantage to be compared.

[1] SA3 refers to an Australian Bureau of Statistics geographic region known as Statistical Area Level 3. The analyses included the 88 SA3s in NSW with populations including at least 100 children aged 0–17.

Spatial distribution of infant and child deaths

Child deaths (aged 0–17)

- The number of SA3s with more than 60 child deaths decreased from 11 in both 2001–2005 and 2006–2010 to 7 in 2011–2015.
- The regions with the highest numbers of child deaths across all three time periods were Southwest and Western Sydney, the Central Coast and Newcastle.
- The SA3 with the highest number of child deaths in 2011–2015 was Campbelltown, followed by Merrylands - Guildford, Mount Druitt, Fairfield, and Blacktown. These five areas accounted for 14.5% of all child deaths in New South Wales in that period.

Child mortality rates (deaths per 100,000 children aged 0–17)

- The gap in child mortality rates between areas has narrowed over time.
- The SA3 with the highest child mortality rate in 2011–2015 was Armidale, followed by Bourke - Cobar - Connamble, Sydney Inner City, Orange, and Taree - Gloucester.
- The SA3 with the lowest child mortality rate in 2011–2015 was Manly, followed by Queanbeyan, Upper Murray excluding Albury, Pennant Hills - Epping, and Wollondilly. The child mortality rate in the Armidale SA3 was 4.5 times as high as that in the Manly SA3.
- No SA3 had a significant increase in its child mortality rates between 2001 and 2015, and there was a significant decrease in 18 SA3s.

Infant deaths

- The number of SA3s with more than 40 infant deaths decreased from 13 in 2005–2009 to 8 in 2010–2014.
- In 2010–2014, 7 of the 8 SA3s with more than 40 infant deaths were concentrated in the greater Sydney region (the 8th was Newcastle).
- The SA3 with the highest number of infant deaths in 2010–2014 was Campbelltown, followed by Merrylands - Guildford, Mount Druitt, Fairfield, and Blacktown. These 5 SA3s combined accounted for 16% of all infant deaths in New South Wales in 2010–2014.

Infant mortality rates (infant deaths per 1,000 live births)

- There is much less variation between areas in recent infant mortality rates than in the earlier periods.
- The SA3 with the highest infant mortality rate in 2010–2014 was Orange, followed by Kempsey - Nambucca, Taree - Gloucester, Upper Hunter, and Moree - Narrabri.
- The SA3 with the lowest infant mortality rate in 2010–2014 as Dural - Wisemans Ferry, followed by Albury, Warringah, North Sydney - Mosman, and Eastern Suburbs - South. An additional 9 SA3s had between 1 and 4 infant deaths, so their infant mortality rates could not be calculated.
- No SA3 had a significant increase in its infant mortality rate over the period, and 13 SA3s had a significant decrease in their infant mortality rate.

Variations by area-level characteristics

The risk of dying during childhood was greater for children living in more disadvantaged areas; this pattern was consistent across all included indicators. The likelihood of dying during childhood in New South Wales in 2011–2015 was:

- 1.7 times as high for children in high poverty areas as for those in low poverty areas
- 1.8 times as high for children in areas with the lowest levels of school engagement among 16-year-olds as for those in the areas with the highest levels of school engagement
- 1.5 times as high for children in areas with the highest levels of overcrowded housing as for those in the areas with the lowest levels of overcrowded housing
- 2.0 times as high for children in areas where 15% or more of children had been assessed as developmentally vulnerable on at least 2 of the 5 domains of the Australian Early Development Census (AEDC). This difference persists across all causes of death, where those in the areas of highest vulnerability were 1.8 times as likely to die of natural causes and 1.9 times as likely to die from external causes (such as transport-related accidents, accidental poisoning, drowning).

Suggestions for future research

Because of small numbers, detailed rates by specific causes of death could not be calculated reliably. Although the project would also have liked to focus more specifically on the risk of death for Indigenous children and for those with a child protection history, it was hampered both by small number issues and accurate data on the at-risk population. Future work could focus more specifically on these groups.

The analyses in this report are descriptive in nature and rely on aggregate mortality rates. Ideally, future analyses would be able to model the effect of individual- and area-level characteristics on the risk of child death, not just on the cause of death distribution among those children who have died. This would require linking the CDRT's data with perinatal and births data to create a longitudinal data set.

1 Introduction

In 2015, 504 children aged from birth to 17 died in New South Wales, representing a child mortality rate of 29.6 deaths per 100,000 children.[2] Although the child mortality rate in New South Wales has declined significantly since 2001 (when it was 43.0 per 100,000), the death of any baby, child or young person is devastating for the families and communities involved (NSW CDRT 2016a).

The New South Wales Child Death Review Team (CDRT) is charged with preventing and reducing the number of deaths to children in New South Wales.[3] To do this, it maintains a register of all child deaths occurring in the state, identifies trends and patterns in the data, and recommends legislation, policies, practices and services to prevent or reduce the likelihood of child deaths (NSW CDRT 2016a). The other key function of the CDRT is to identify topics requiring further research, and to undertake and/or commission research to fill these gaps (NSW CDRT 2014, 2015a, 2015b, 2016b).

It is well established that the risk of dying during childhood is not randomly distributed throughout society, but varies by children's individual and family characteristics as well as by the characteristics of the areas in which they live. Mortality rates are higher for children who were born pre-term, small for gestational age and/or with congenital and chromosomal conditions; those with chronic health conditions; those living in overcrowded or poor-quality housing; those with a child protection history; [4] and Aboriginal and Torres Strait Islander children. Mortality rates are also more than twice as high for children living in areas with the highest levels of socioeconomic disadvantage as for those living in the least disadvantaged areas, and are lower in cities compared with regional and remote areas (AIHW 2017; NSW CDRT 2014, 2016a).

What is unknown, however, is the extent to which the risk of child death varies across **specific** geographic areas within New South Wales, and the area-level characteristics that are associated with those variations.

In 2016, the CDRT engaged the Australian Institute of Health and Welfare (AIHW) to undertake a series of geospatial analyses using the CDRT's child deaths data, as identifying geographic areas with high numbers of child deaths and child mortality rates can provide opportunities for targeted interventions.

The project had four main aims:

- provide the CDRT with a set of maps of the residential locations of children who died in New South Wales (by particular characteristics or causes of death, such as suicide)

---

[2] The child mortality rate is the number of deaths of children aged 0–17, divided by the number of children aged 0–17, and is expressed as the number of deaths per 100,000.

[3] The CDRT is governed by Part 5A of the *Community Services (Complaints, Reviews and Monitoring) Act 1993* (NSW) (CS CRAMA). It currently sits within the NSW Ombudsman's Office. The Ombudsman's Office has separate responsibility for reviewing the deaths of children in circumstances of abuse or neglect, and the deaths of children in care or detention.

[4] This includes children, or siblings of children, who were the subject of a report of risk of harm to the Department of Community Services within 3 years before their death (2002–2009). From 2010, this includes children (and siblings of children) who were the subject of a report of risk of harm/significant harm to Community Services and/or to a Child Wellbeing Unit within 3 years before their death.

- describe area-level patterns in child deaths across New South Wales
- examine how the risk of child death varies by area-level characteristics
- test whether adding area-level characteristics to individual-level child deaths data affects the cause of death distribution, above and beyond the individual-level characteristics of the child. This aim builds on the work that the AIHW previously conducted for the CDRT (NSW CDRT 2014).

This report highlights the key findings from this project.[5]

Child deaths data

The CDRT supplied the AIHW with individual-level records from its internal database for the period 2001–2015. The CDRT receives data directly from the NSW Registry of Births Deaths and Marriages and classifies each death using the International Statistical Classification of Diseases and Related Health Problems, tenth revision, Australian modification (ICD-10-AM). The CDRT also adds special codes for deaths classified as SUDI (sudden unexpected death in infancy) and those classified as suicide.

The key variables in the CDRT register include year of death, demographic characteristics, child protection status, cause of death, geographic information, and contextual variables (Table 1.1).

Table 1.1: Variables in the NSW CDRT register

Category	Variables
Year of death	Calendar year
Demographic characteristics	Gender
	Age at death
	Indigenous status
Child protection status	Child protection history
	In care at the time of death
Cause of death	Broad cause of death (*assault, drowning, suicide, transport, other unintentional external cause, natural cause, pending*)
	SUDI (sudden unexpected death in infancy)
	Underlying cause of death (ICD-10-AM)
	Contributing causes of death (ICD-10-AM)
Geographic	Address of residence at the time of death
	Longitude/latitude of residence
	Australian Bureau of Stattistics (ABS) Australian Statistical Geography Standard (ASGS) SA structure, 2012 and after
Context	Remoteness, 2012 and after
	Area-level Socio-Economic Indexes for Areas (SEIFA) scores, 2012 and after

[5] This report does not include the maps of residential locations of children who died in NSW, nor does it include information on the detailed characteristics of children who died in particular areas because of confidentiality issues. The findings from the last aim, the multilevel analyses, are referred to in Chapter 5, but are not discussed in detail in this report.

The two contextual-level variables (remoteness and socioeconomic status) were available for 2012 and later. The AIHW added these variables for deaths occurring in all other years, along with extra contextual variables (described in Chapter 4). The original data set included 8,918 records. Of those, 64 had no address and therefore no geocodes; another 197 records were for children whose deaths occurred in New South Wales, but whose residence was outside the state. The final data set for analysis includes the 8,657 geocoded records of children who died in New South Wales between 2001 and 2015, and who resided in the state when they died.

Analytic approach

The overall approach to this project was to use the available data in a conceptually based, methodologically rigorous manner (including descriptive and statistical analyses, as appropriate) to provide the CDRT with information that will be useful to its ongoing work. To that end, the report includes both counts and rates, as each provides complementary information (Box 1.1).

Box 1.1: Counts and rates—what do they tell us?

Counts of deaths and child mortality rates are both useful area-level indicators:

- Counts are the aggregated number of deaths in a particular area. They can be computed by cause, age group or population group. They are useful for identifying areas where location-based interventions or risk reduction strategies could be helpful. However, counts cannot be used to compare the risk of death across areas because the number of deaths in an area may be high simply because there are larger numbers of children in that area compared with others.
- Mortality rates (the number of deaths per 100,000 population) are a measure of the risk of dying. They are useful for comparing the risk of dying across geographic areas or across particular causes of death, population groups and across time. However, it is important to note that even if an area has a high mortality rate, the actual number of deaths in that area may be low.

The next sections describe the methodology underpinning the two sets of analyses presented in this report: how child death varies across particular geographic areas within New South Wales (2001–2015), and how the risk of child death varies by area-level characteristics (2011–2015).

Geographic variation in child deaths

Several key questions were considered in these analyses:

- Which geographic areas have the highest numbers of child deaths?
- Which areas have the highest child mortality rates?
- Has the variation between areas changed over time?
- Are there any individual areas that have seen significant increases or decreases in child mortality rates between 2001 and 2015?

The steps underpinning the analyses are outlined in Figure 1.1.

Figure 1.1: Overview of approach for area-level analysis

Geographic unit of analysis

Each death is geocoded to a point location, offering flexibility in the choice of geographic classification system and level. For this project, the AIHW recommended the ABS ASGS, with its hierarchical SA structure, as the most appropriate classification system (more detail is provided in Appendix A).

Within the SA structure, SA3s were chosen as the most suitable level for the calculation and presentation of the counts and rates, as they are large enough to provide robust estimates, but small enough to be meaningful. There are 88 SA3s included in the analyses. Three (3) SA3s were excluded due to small population numbers: Lord Howe Island, Blue Mountains - South, and Illawarra Catchment Reserve. A map of the SA3s in New South Wales is provided in Figure 1.2.

For each SA3 to be identified, the names of the SA3s outside the greater Sydney region appear on the areas themselves or with lines linking them to their locations. For the 49 SA3s within the Sydney region, numbers are used that correspond with the set of names to the left of the inset map.

Figure 1.2: Map of SA3 boundaries in New South Wales

Outcome measures

Although the primary focus of this report is on child mortality (from birth to 17 years), information on the distribution of infant mortality is included as well (Box 1.2), as deaths during infancy account for approximately 60% of all child deaths. To ensure reliability in the rates, data are combined into 5-year periods.

Box 1.2: Outcome variables

- **SA3 level infant mortality rates** are calculated as the number of deaths of babies aged under 1 in an SA3 divided by the number of live births in that SA3, and are expressed as the number of infant deaths per 1,000 live births. The denominators (live births at the SA3 level by year) were sourced from the ABS (2016)[6] and were available for each year between 2001 and 2014. Rates were calculated for three time periods (2001–2004, 2005–2009, 2010–2014).
- **SA3 level child mortality rates** are calculated as the number of deaths to children aged 0–17 in an SA3 divided by the number of children aged 0–17 in the SA3, and are expressed as the number of deaths per 100,000 children. The population data (the numbers of children aged 0–17 per SA3 for each year between 2001 and 2015) are from the ABS Estimated Resident Population (ERPs) at the SA3 level (ABS 2017).[7] Rates were calculated for three time periods (2001–2005, 2006–2010, 2011–2015).

Rates are only calculated for areas where there is a minimum of 5 deaths in the numerator and a denominator of at least 100.

Spatial patterns in the data

A series of tests found that there were no significant spatial patterns when examining all causes of death, and very weak spatial clustering concerning external causes. Further tests for spatial autocorrelation/hotspots of specific causes of death (such as suicide) showed that there are no regional clusters indicating a higher than expected degree of child deaths across New South Wales. Thus, there is likely to be little impact on any statistical tests that rely on assumptions of independence.

Descriptive analyses

Variation between areas was examined through the use of SA3-level descriptive statistics (such as the mean, median, minimum, maximum), and the spatial distribution of the rates and counts are illustrated using choropleth maps by 5-year time period.

Testing for change over time

Poisson regression was used to examine whether changes in child mortality over time were statistically significant for each individual SA3 using 3-year time periods.

[6] Available at SA2-level. AIHW aggregated them to SA3-level.

[7] Yearly SA3-level population data are available in 5-year age groups. The population numbers for the 15–17-year-old age group were calculated by dividing the 15–19-year-old populations by 5, then multiplying by 3.

Variation in child mortality by area-level characteristics

The second set of analyses focused on how the risk of child death varies by the characteristics of the areas in which children live. These analyses focus on child deaths from 2011–2015.The steps underpinning the analyses are outlined in Figure 1.3.

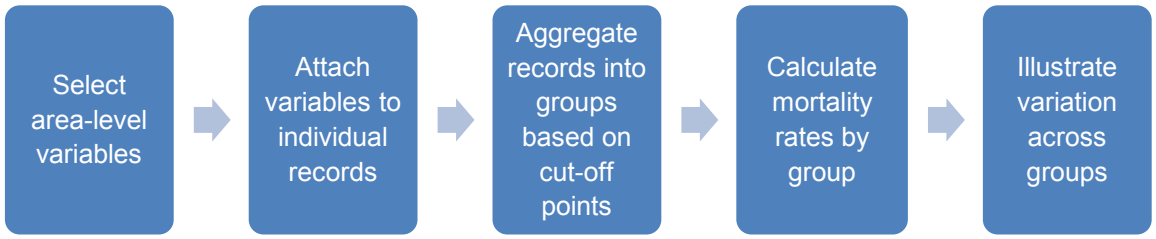


Figure 1.3: Overview of steps in descriptive analyses of variations by area-level characteristics

Selection of area-level characteristics

Variables were selected at the SA2 or SA3 level within 4 domains (economic context, social capital, housing, child health and development) that are conceptually linked with the risk of child mortality. It is important to emphasise that these variables represent the context in which children live, such as the poverty or unemployment rate of the area. They do not reflect the characteristics of all the children or families who live in that area. For example, even if a child lives in an area of relatively high poverty, it does not mean that that particular child lives in poverty.

The selected variables included indicators of a single concept (such as poverty, educational attainment) and multidimensional indicators (socioeconomic status, developmental vulnerability). The advantage of single variables is that there is a clear conceptual pathway between the variable and the outcome. The disadvantage is that a single variable may still reflect a number of other underlying processes (Saunders 2012). Conversely, indexes may better capture local environments; however, even if an index is associated with an outcome, it may be difficult to tell which aspect of the index is having the most impact.

The indicators included subjective measures (such as people's reports of financial stress) as well as objective measures (such as unemployment rates). More detail about the variables is included in Chapter 4.

Linkage to individual records

As discussed previously, each individual record in the CDRT database has a geocode, along with the appropriate SA2 and SA3 codes for their residential location. The contextual information was attached to each record using these codes.

Defining groups of areas

The descriptive analysis is based on grouping areas with similar values, then comparing mortality rates across these groups. The variables in the first 3 domains (economic context, social capital, housing) were grouped together using a relative approach. That is, areas were sorted from low to high on their values, then the areas were divided into quartiles (except for the SEIFA Index of Relative Socio-economic Disadvantage—IRSD—which was divided into deciles). A different approach was used for the child health and development variables, in which areas were grouped into pre-set categories.

Calculation of mortality rates

Once the geographic areas were grouped together, so, too, were the child deaths and population data (number of children aged 0–17), and were used to calculate a mortality rate that reflects the risk of dying for all children living in areas with similar values on the area-level characteristic.

Variation across groups

Once the mortality rates have been calculated, the variation across areas can be easily compared using rate differences and rate ratios (Ring et al. 2016).

- The **rate difference** refers to the absolute size of the difference in the rates between two groups of areas (such as those in areas of high poverty compared with areas of low poverty). It is obtained by subtracting the lower from the higher rate.
- The **rate ratio** is calculated by dividing the child mortality rate in one group by that of another group (such as the child mortality rate in the areas with the highest poverty rates by the mortality rate in the areas with the lowest poverty rates). A rate ratio of 1 indicates that the values are the same between the areas. Rate ratios of greater than 1 indicate a higher prevalence, while rate ratios of less than 1 indicate a lower prevalence.

Cautions

Some cautions must be exercised when interpreting the findings:

- The extent of the differences depends on how areas were divided into particular categories for each variable. For example, for most variables, areas were grouped into quartiles. The advantage of this approach is that it is straightforward and allows for easy comparison across groups. The disadvantage is that there may be particular values that are 'tipping points' that are not captured. Different categories may yield different rate ratios and rate differences.
- The approach treats all areas within a particular category (for example, all those with a relatively high poverty rate) as if they are the same.
- A number of the variables are related to one another—for example, housing stress is related to economic context; child vulnerability is associated with social capital. Thus, part of the observed relationship between the variable of interest and child mortality might be partly due to other underlying variables.

In spite of these cautions, however, these descriptive analyses provide high-level information about how child mortality varies by a number of area-level characteristics.

Report structure

Chapters 2 and 3 focus on the spatial distribution of child deaths (ages 0–17) and infant deaths, respectively. Each chapter presents descriptive statistics on variation across SA3s and uses maps to illustrate the geographic distribution of deaths and rates across the state. The chapters also include information on the areas with the highest numbers of deaths and highest mortality rates.

Chapter 4 focuses on how child mortality varies by area-level characteristics, while Chapter 5 presents suggestions for further research. A detailed description of the selection of the geographic level of analysis is presented in Appendix A, and Appendix B includes additional detailed tables.

2 Geographic distribution of child deaths (ages 0–17)

This chapter illustrates how child deaths are distributed across SA3s within New South Wales. It begins with an overview of the characteristics of child deaths between 2011 and 2015, then focuses on the distribution of area-level numbers and rates of child deaths.

Box 2.1 presents a high-level overview of all child deaths, deaths of Aboriginal and Torres Strait Islander children, and deaths of children with a child protection history in 2011–2015 (see detailed tables in Appendix B, including for all deaths between 2001 and 2015).

Box 2.1: Child deaths in New South Wales, 2011–2015

All child deaths

- There were 2,574 deaths in New South Wales of children aged 0–17 who lived in New South Wales when they died. This is equivalent to a child mortality rate of 31.5 deaths per 100,000 children aged 0–17.
- The highest proportion of deaths occurred during infancy (61.9%), followed by ages 15–17 (12.1%) and 1–4 (11.1%).
- Nearly 10% of deaths were to Aboriginal and Torres Strait Islander children (9.8%).
- One-fifth of deaths were to children with a child protection history (20.2%).
- The majority of deaths (75.9%) were from natural causes. This includes 33.6% from conditions arising in the perinatal period, 18.2% from congenital and chromosomal conditions, 7.9% from cancer, and 6.0% from diseases of the nervous system.
- The most frequent external causes of death were transport-related (5.7%), suicide (3.9%), drowning (2.2%) and assault (1.1%).
- Sudden Infant Death Syndrome (SIDS) and other unknown causes[8] accounted for 6.6% of all child deaths (9.4% of all infant deaths).

Deaths of Aboriginal and Torres Strait Islander children

Compared with non-Indigenous child deaths, a higher proportion of Indigenous child deaths:

- occurred during infancy (66.8% vs 61.6%)
- were to children with a child protection history (53.8% vs 16.3%)
- occurred outside major cities (59.7% vs 25.5%)
- were due to external causes or SIDS and other unknown causes (36.4% vs 20.9%).

Deaths of children with a child protection history

- A higher proportion of deaths of children with a child protection history occurred to older children (36.4% at ages 5 and older vs 25.1% of those without a history).
- External causes and SIDS and other unknown causes made up a much higher percentage of child deaths of those with a child protection history compared with those without a child protection history (41.4% vs 17.9%).

[8] ICD-10 codes R95, R99.

Number of child deaths

SA3-level counts highlight the geographic areas with the highest numbers of child deaths. This information is important from a policy perspective, as it can assist with targeting place-based programs and interventions. For example, if an SA3 (or a group of SA3s) has a large number of deaths from conditions originating during pregnancy and birth, there may be opportunities to reduce the number of child deaths by focusing on maternal health, while areas with a high number of deaths classified as SUDI might lead to programs reinforcing safe sleeping messages among parents and carers in those areas.

Variation across areas

The overall decline in the number of child deaths in New South Wales over the last 15 years is reflected in Table 2.1, which illustrates the extent of the variation between SA3s over time. The average number of deaths per SA3 declined from 36 in 2001–2005 to 29 in 2011–2015, while the lowest number of deaths in an area declined from 6 in 2001–2005 to 1 in 2011–2015. The maximum number of deaths in an area also declined, from a high of 118 in 2006–2010 to 88 in 2011–2015.

Table 2.1: Number of child deaths, by SA3 and time period, descriptive statistics

Statistic	2001–2005	2006–2010	2011–2015
Mean	36	33	29
Median	32	26	26
Standard deviation	21.1	22.4	18.4
Minimum	6	4	1
Maximum	103	118	88
Number of SA3s with valid data[(a)]	88	88	88
Total number of child deaths in NSW	**3,176**	**2,907**	**2,574**

(a) SA3s with at least 100 children (aged 0–17).

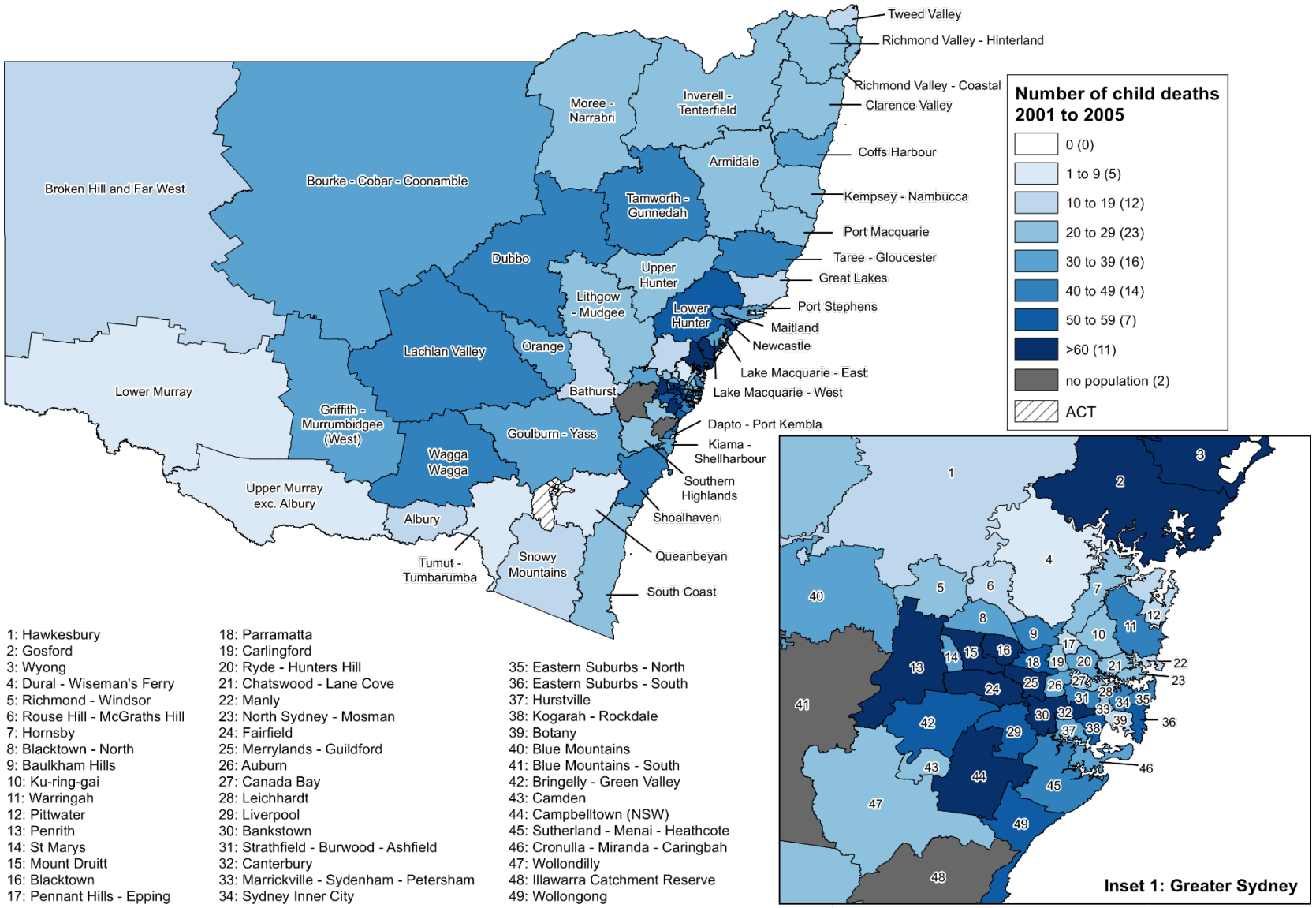
Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

How those deaths are distributed across New South Wales is shown in choropleth maps in Figure 2.1 (2001–2005), Figure 2.2 (2006–2010) and Figure 2.3 (2011–2015). Darker blues represent higher numbers of deaths.

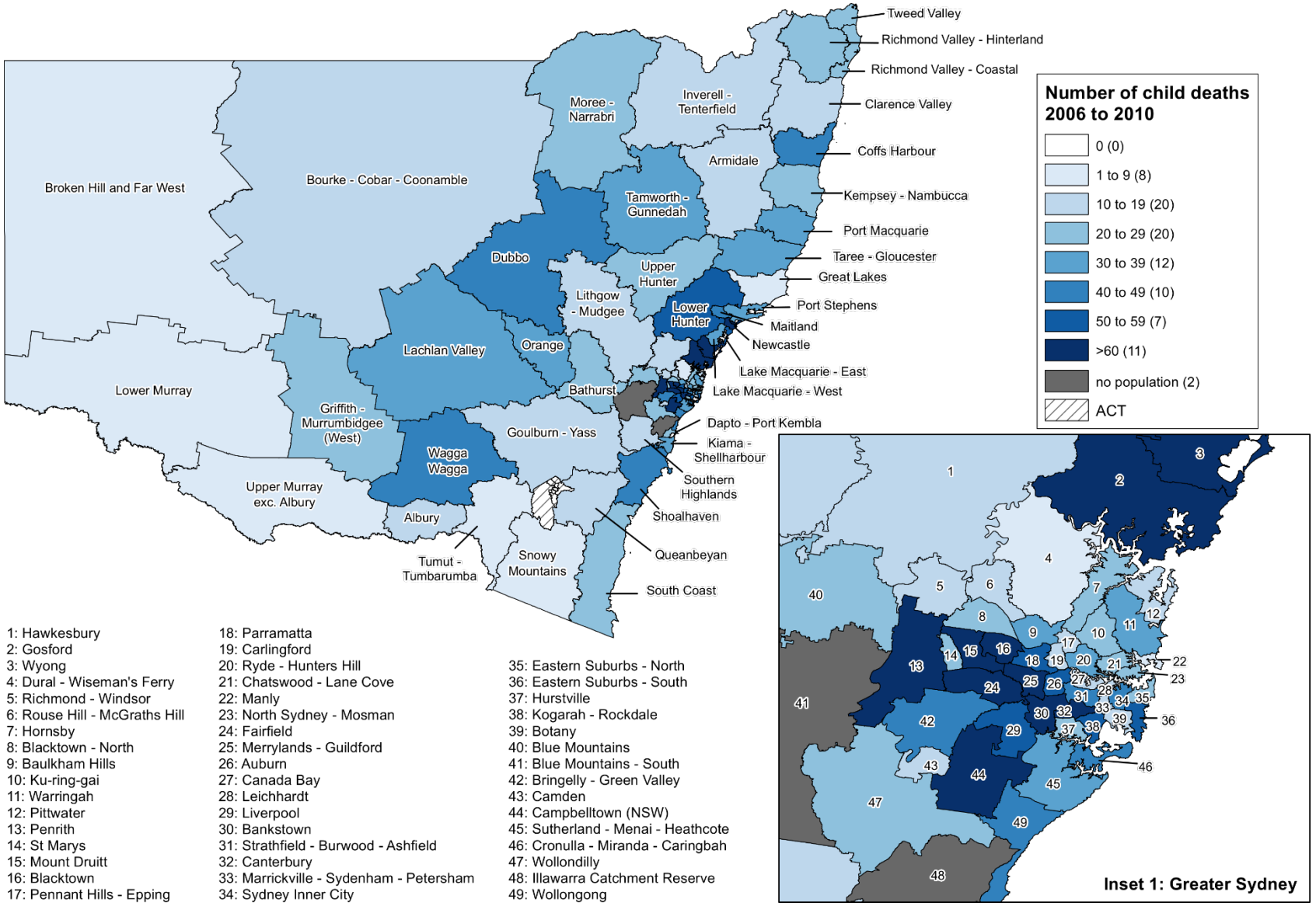
The data in the maps show that:

- the number of SA3s with fewer than 10 child deaths increased from 5 in 2001–2005, to 8 in 2006–2010, and 11 in 2011–2015
- the number of SA3s with more than 60 child deaths decreased from 11 in both 2001–2005 and 2006–2010 to 7 in 2011–2015
- the regions with the highest numbers of child deaths across all three time periods were Southwest and Western Sydney, the Central Coast and Newcastle.



1: Hawkesbury
2: Gosford
3: Wyong
4: Dural - Wiseman's Ferry
5: Richmond - Windsor
6: Rouse Hill - McGraths Hill
7: Hornsby
8: Blacktown - North
9: Baulkham Hills
10: Ku-ring-gai
11: Warringah
12: Pittwater
13: Penrith
14: St Marys
15: Mount Druitt
16: Blacktown
17: Pennant Hills - Epping
18: Parramatta
19: Carlingford
20: Ryde - Hunters Hill
21: Chatswood - Lane Cove
22: Manly
23: North Sydney - Mosman
24: Fairfield
25: Merrylands - Guildford
26: Auburn
27: Canada Bay
28: Leichhardt
29: Liverpool
30: Bankstown
31: Strathfield - Burwood - Ashfield
32: Canterbury
33: Marrickville - Sydenham - Petersham
34: Sydney Inner City
35: Eastern Suburbs - North
36: Eastern Suburbs - South
37: Hurstville
38: Kogarah - Rockdale
39: Botany
40: Blue Mountains
41: Blue Mountains - South
42: Bringelly - Green Valley
43: Camden
44: Campbelltown (NSW)
45: Sutherland - Menai - Heathcote
46: Cronulla - Miranda - Caringbah
47: Wollondilly
48: Illawarra Catchment Reserve
49: Wollongong

Figure 2.1: Number of deaths to children aged 0–17 in NSW, by SA3 of residence, 2001–2005



1: Hawkesbury
2: Gosford
3: Wyong
4: Dural - Wiseman's Ferry
5: Richmond - Windsor
6: Rouse Hill - McGraths Hill
7: Hornsby
8: Blacktown - North
9: Baulkham Hills
10: Ku-ring-gai
11: Warringah
12: Pittwater
13: Penrith
14: St Marys
15: Mount Druitt
16: Blacktown
17: Pennant Hills - Epping
18: Parramatta
19: Carlingford
20: Ryde - Hunters Hill
21: Chatswood - Lane Cove
22: Manly
23: North Sydney - Mosman
24: Fairfield
25: Merrylands - Guildford
26: Auburn
27: Canada Bay
28: Leichhardt
29: Liverpool
30: Bankstown
31: Strathfield - Burwood - Ashfield
32: Canterbury
33: Marrickville - Sydenham - Petersham
34: Sydney Inner City
35: Eastern Suburbs - North
36: Eastern Suburbs - South
37: Hurstville
38: Kogarah - Rockdale
39: Botany
40: Blue Mountains
41: Blue Mountains - South
42: Bringelly - Green Valley
43: Camden
44: Campbelltown (NSW)
45: Sutherland - Menai - Heathcote
46: Cronulla - Miranda - Caringbah
47: Wollondilly
48: Illawarra Catchment Reserve
49: Wollongong

Figure 2.2: Number of deaths to children aged 0–17 in NSW, by SA3 of residence, 2006–2010

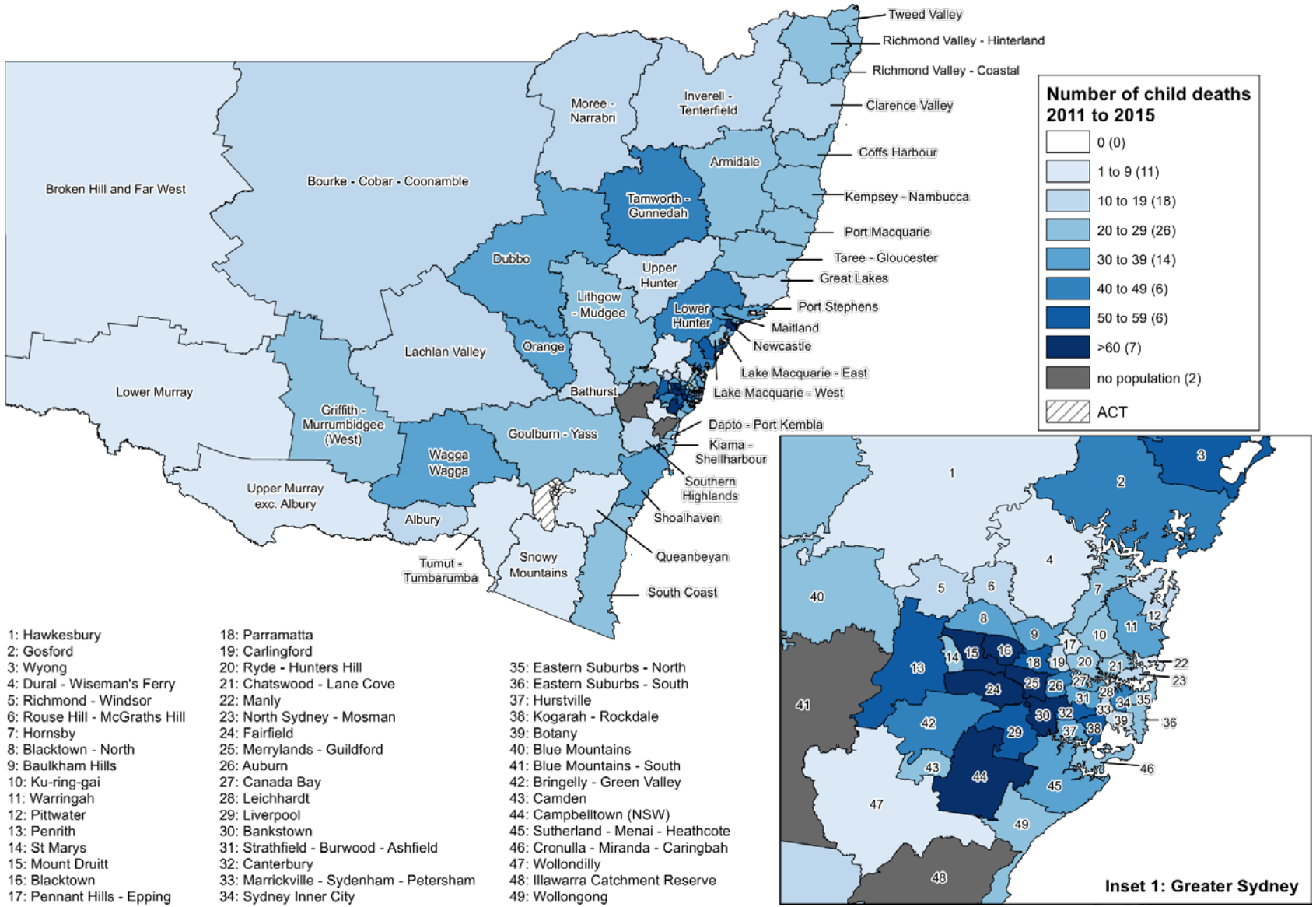


Figure 2.3: Number of deaths to children aged 0–17 in NSW, by SA3 of residence, 2011–2015

Areas with the highest number of child deaths

Table 2.2 presents the 5 SA3s with the highest number of deaths in each period, along with each area's child mortality rate.

Table 2.2: The 5 SA3s with the highest number of child deaths by period

2001–2005			2006–2010			2011–2015		
SA3	**Deaths**	**Mortality rate**	**SA3**	**Deaths**	**Mortality rate**	**SA3**	**Deaths**	**Mortality rate**
Campbelltown	103	45.9	Campbelltown	118	57.0	Campbelltown	88	44.1
Merrylands - Guildford	86	54.4	Mount Druitt	100	61.9	Merrylands - Guildford	78	41.5
Bankstown	85	45.0	Fairfield	87	38.5	Mount Druitt	72	43.8
Fairfield	84	36.2	Bankstown	85	41.8	Fairfield	68	30.2
Canterbury	82	54.3	Newcastle	73	44.3	Blacktown	67	40.9
NSW total	**3,176**	**40.3**	**NSW total**	**2,907**	**36.6**	**NSW total**	**2,574**	**31.5**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Table 2.2 shows that:

- an area can have a high number of deaths while having a relatively low child mortality rate. For example, Fairfield had the fourth highest number of child deaths in 2011–2015 but, in terms of mortality rates, it was ranked 46th highest
- except for Newcastle in 2006–2010, the SA3s with the top five highest numbers of child deaths were all in Southwest and Western Sydney
- the five SA3s with the highest numbers of child deaths combined accounted for 13.9% of all child deaths in New South Wales in 2001–2005, 15.9% of child deaths in 2006–2010, and 14.5% of all child deaths in New South Wales for 2011–2015.

Causes of death

Identifying the geographic areas with the highest number of child deaths is only the first step towards preventing future deaths. Further information on the characteristics and causes of death in those areas is necessary to understand where further efforts could be targeted.

More detailed analyses of these five areas for the CDRT found that there was a great deal of variation between areas in the characteristics of the children who died[9] and the causes of death in those areas (Table 2.3). The findings highlight the importance of understanding what is happening at local levels. For example, while 33.6% of all child deaths in New South Wales in 2011–2015 were due to conditions arising in the perinatal period, in Blacktown it was 50.8%. The percentage of deaths from SIDS and other unknown causes was 6.6% at the state level, but in Mount Druitt it was 13.9%.

[9] Detailed characteristics are not presented for confidentiality reasons. The AIHW also provided the CDRT with information on deaths of Aboriginal and Torres Strait Islander children and deaths of children with a child protection history in the SA3s that had the highest numbers of deaths to children in those groups.

Table 2.3: Distribution of high-level causes of death within the 5 SA3s with the highest numbers of child deaths, 2011–2015

	%					
Cause of death	**Campbelltown**	**Merrylands - Guildford**	**Mount Druitt**	**Fairfield**	**Blacktown**	**NSW**
Natural	77.3	82.1	75.0	82.4	80.6	75.9
(Conditions arising in the perinatal period)	*(37.5)*	*(34.6)*	*(37.5)*	*(33.8)*	*(50.8)*	*(33.6)*
External	17.1	11.5	9.7	14.7	13.4	16.0
SIDS and other undetermined	5.7	3.9	13.9	2.9	6.0	6.6
Pending	0.0	2.6	1.4	0.0	0.0	1.6
Total %	**100**	**100**	**100**	**100**	**100**	**100**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW. Column totals may not sum to 100 because of rounding.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Key findings – number of child deaths

- The number of SA3s with fewer than 10 child deaths increased from 5 in 2001–2005, to 8 in 2006–2010, and 11 in 2011–2015.
- The number of SA3s with more than 60 child deaths decreased from 11 in both 2001–2005 and 2006–2010 to 7 in 2011–2015.
- The regions with the highest numbers of child deaths across all three time periods were Southwest and Western Sydney, the Central Coast and Newcastle.
- The SA3 with the highest number of child deaths in 2011–2015 was Campbelltown, followed by Merrylands - Guildford, Mount Druitt, Fairfield, and Blacktown. These five areas accounted for 14.5% of all child deaths in New South Wales in that period.
- An area can have a high number of deaths while having a relatively low child mortality rate. For example, Fairfield had the fourth highest number of child deaths in New South Wales in 2011–2015, but its child mortality rate ranked 46th within the state for that same period.

Child mortality rates

While the aggregate numbers of deaths are important, they do not illustrate how the *risk* of death during childhood varies across areas. For that, mortality rates are required. This section illustrates how child mortality rates are distributed across SA3s within New South Wales and presents information on the SA3s with the highest and lowest rates.

Variation across areas

SA3-level child mortality rates were calculated for 2001–2005, 2006–2010 and 2011–2015. The variation in the area-level rates is shown in Table 2.4.

Table 2.4: Descriptive statistics, SA3-level child mortality rates[(a)], by period

Statistic	2001–2005	2006–2010	2011–2015
Mean	40.4	35.1	31.2
Median	41.7	35.9	31.0
Standard deviation	11.7	11.3	10.1
Minimum	13.8	10.5	12.7
Maximum	81.3	61.9	57.5
Number of SA3s where rates could be calculated[(b)]	88	87	85
Total number of child deaths in NSW	**3,176**	**2,907**	**2,574**

(a) Deaths of children aged 0–17 per 100,000.

(b) SA3s with at least 100 children (aged 0–17) and at least 5 deaths.

Notes: The table includes only those deaths where the children's residential address was in NSW at the time of their death and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

The data show that:

- the mean SA3-level child mortality rate declined from 40.4 in 2001–2005 to 31.2 in 2011–2015
- there was a narrowing of the gap between the areas over time:
  - in 2001–2005, the highest SA3-level child mortality rate was 81.3 deaths per 100,000 children aged 0–17, and there was a gap of 67.4 deaths per 100,000 between the areas with the lowest and highest rates
  - by the most recent period, the highest child mortality rate was 57.5 per 100,000, and the gap between the areas with the lowest and highest rates had narrowed to 44.8 deaths per 100,000.

Figure 2.4 (2001–2005), Figure 2.5 (2006–2010) and Figure 2.6 (2011–2015) show the distribution of the child mortality rates across New South Wales. Darker blues represent higher child mortality rates. The ranges and colours are consistent between the maps.

The data in the maps show that:

- the number of SA3s with child mortality rates below 20.0 per 100,000 increased from 4 in 2001–2005 to 12 in 2011–2015
- the number of SA3s with child mortality rates of 60.0 per 100,000 or higher decreased from 4 in 2001–2005, to 2 in 2006–2010, and to 0 in 2011–2015
- the SA3s with the highest child mortality rates were a mix of larger regional areas and areas within the greater Sydney region.

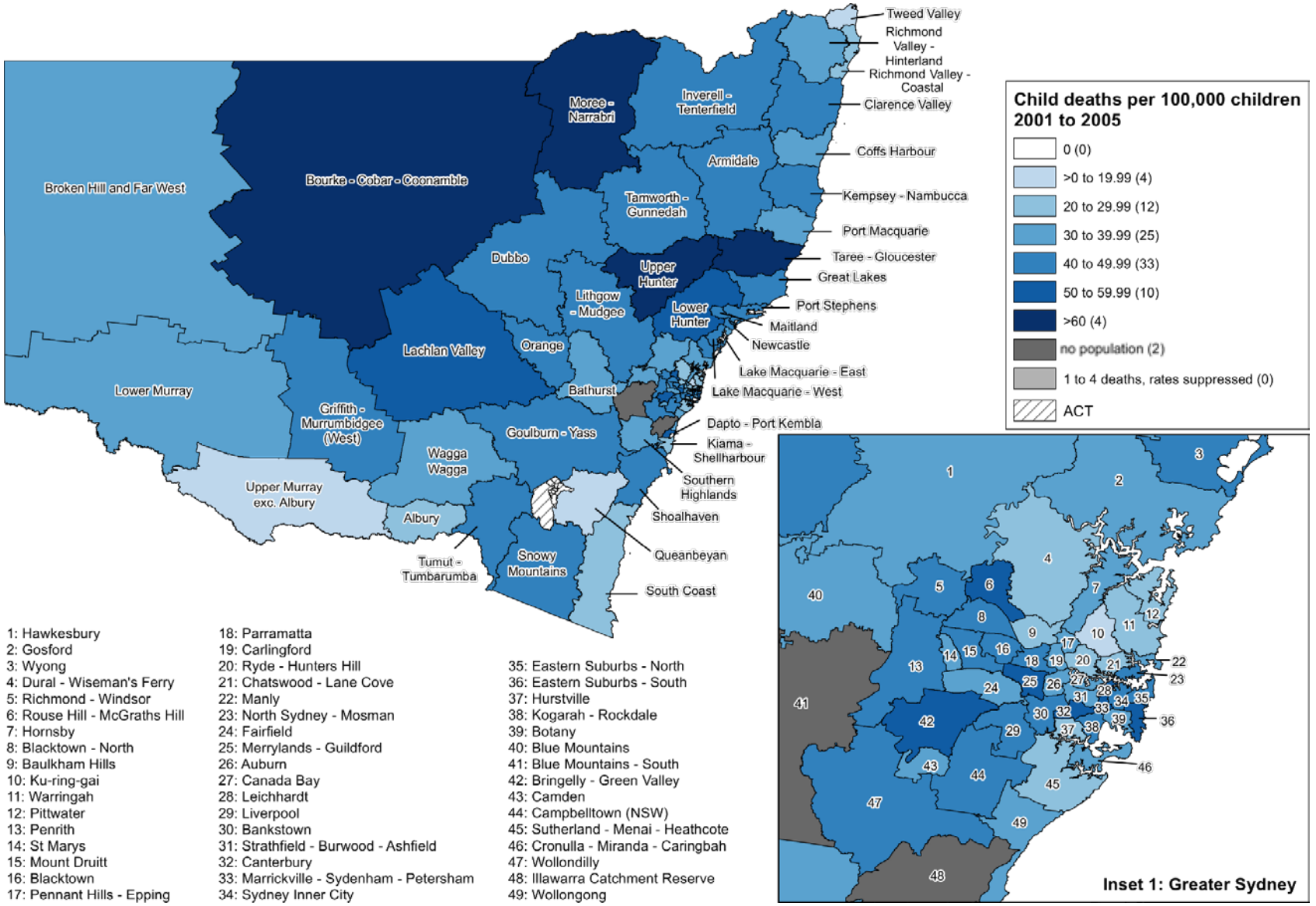


Figure 2.4: Mortality rates, children aged 0–17 in NSW, by SA3 of residence, 2001–2005

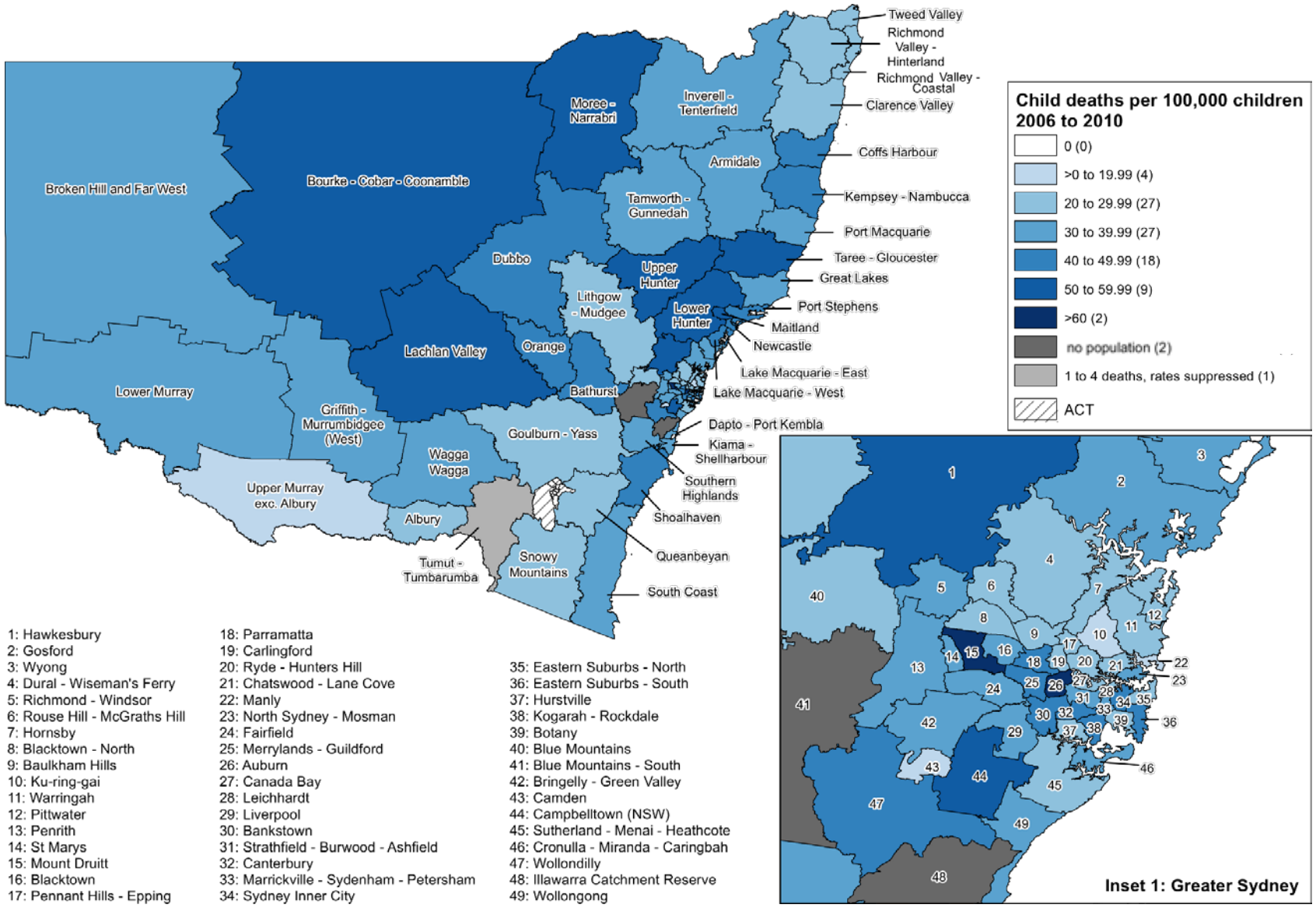


Figure 2.5: Mortality rates, children aged 0–17 in NSW, by SA3 of residence, 2006–2010

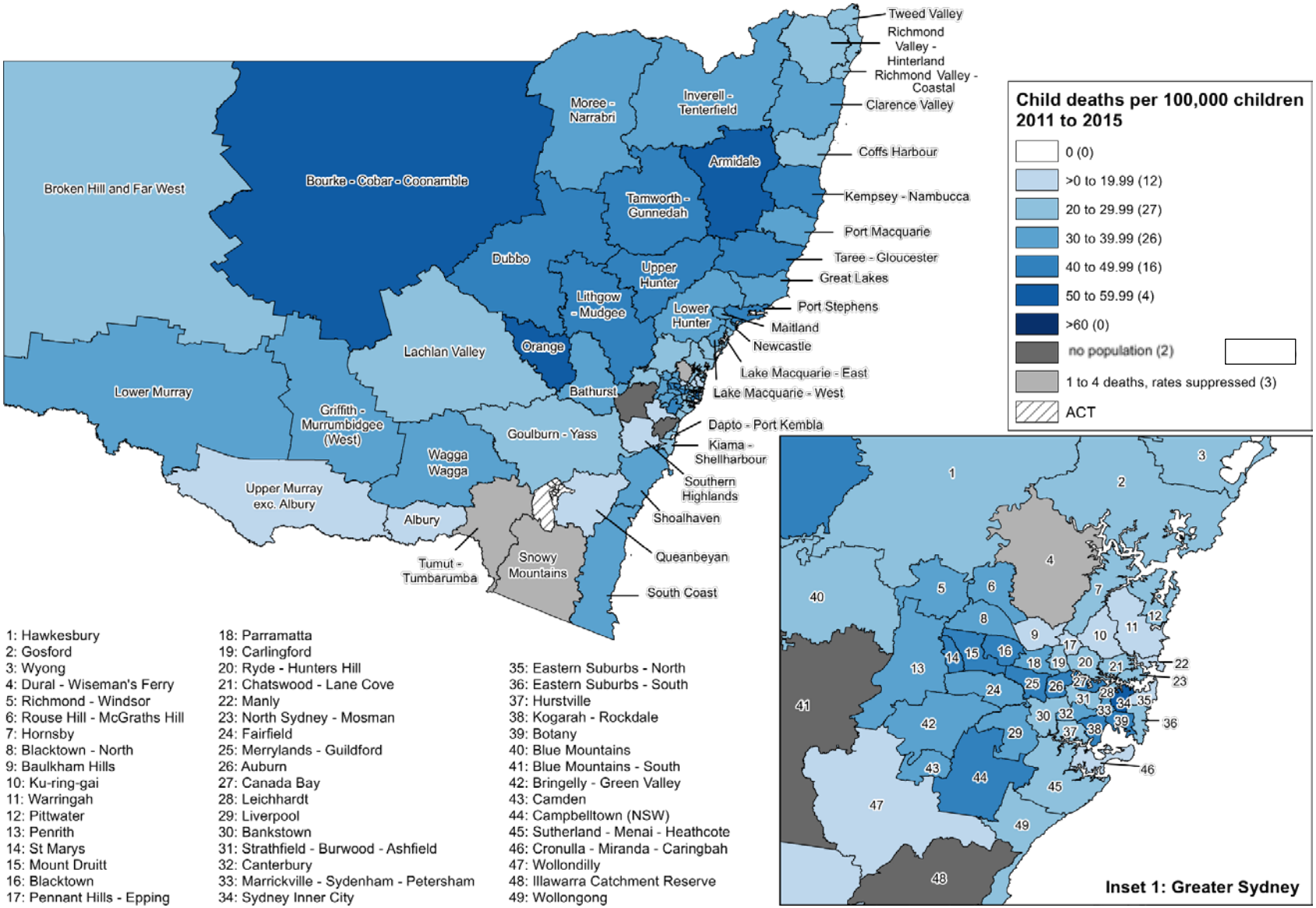


Figure 2.6: Mortality rates, children aged 0–17 in NSW, by SA3 of residence, 2011–2015

Areas with the highest and lowest child mortality rates

Table 2.5 presents the 5 SA3s with the highest child mortality rates in each of the three time periods, along with the number of deaths in those areas. Table 2.6 presents the same information for the 5 SA3s with the lowest child mortality rates.

Table 2.5: The 5 SA3s with the highest child mortality rates, by period

2001–2005			2006–2010			2011–2015		
SA3	Mortality rate	Deaths	SA3	Mortality rate	Deaths	SA3	Mortality rate	Deaths
Bourke - Cobar - Coonamble	81.3	33	Mount Druitt	61.9	100	Armidale	57.5	26
Taree - Gloucester	68.5	43	Auburn	61.1	54	Bourke - Cobar - Coonamble	53.2	18
Moree - Narrabri	67.5	27	Campbelltown	57.0	118	Sydney Inner City	51.2	47
Upper Hunter	67.1	26	Taree - Gloucester	55.1	33	Orange	50.2	38
Marrickville - Sydenham - Petersham	58.4	25	Upper Hunter	54.3	21	Taree - Gloucester	47.7	28
NSW total	**40.3**	**3,176**	**NSW total**	**36.6**	**2,907**	**NSW total**	**31.5**	**2,574**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Table 2.6: The 5 SA3s with the lowest child mortality rates, by period

2001–2005			2006–2010			2011–2015		
SA3	Mortality rate	Deaths	SA3	Mortality rate	Deaths	SA3	Mortality rate	Deaths
Upper Murray exc. Albury	13.8	<10	Upper Murray exc. Albury	10.5	<10	Manly	12.7	<10
Queanbeyan	14.4	<10	Manly	14.6	<10	Queanbeyan	13.3	<10
Tweed Valley	15.8	14	Camden	17.8	13	Upper Murray exc. Albury	13.4	<10
Ku-ring-gai	19.9	26	Ku-ring-gai	17.9	24	Pennant Hills - Epping	14.0	<10
Albury	23.1	17	Baulkham Hills	20.2	34	Wollondilly	17.6	<10
NSW total	**40.3**	**3,176**	**NSW total**	**36.6**	**2,907**	**NSW total**	**31.5**	**2,574**

Notes

1. In 2006–2010, the child mortality rate could not be calculated for Tumut - Tumbarumba because there were fewer than 5 deaths. In 2011–2015, there were 3 SA3s with fewer than 5 deaths: Tumut - Tumbarumba, Snowy Mountains, and Dural - Wisemans Ferry.
2. The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

The tables show several key patterns:

- A high mortality rate does not necessarily imply that there is a large number of deaths in that area. For example, while the child mortality rate in the Armidale SA3 was the highest in New South Wales in 2011–2015 at 57.5 deaths per 100,000 children aged 0–17, the number of children who died in the Armidale SA3 during that period was 26.
- In 2011–2015, the child mortality rate in the Armidale SA3 was 4.5 times as high as that in Manly, with a rate difference of 44.8 deaths per 100,000 children aged 0–17.
- In the 2011–2015 period, there were 3 SA3s with rates that could not be calculated because the number of deaths was too low. Additionally, all 5 of the areas with the lowest rates had fewer than 10 deaths.

Causes of death in the areas with the highest child mortality rates

A high-level overview of the cause of death distribution (Table 2.7) illustrates the characteristics of the children who died in the 5 SA3s with the highest child death rates in 2011–2015. Four (4) of the 5 SA3s are large regional or rural areas—only Sydney Inner City is a metropolitan area. Although Bourke - Cobar - Coonamble has a relatively small number of deaths, its child mortality rate is the second highest in the state, and 78% of the deaths were to Indigenous children.

Table 2.7: Characteristics of child deaths in the 5 SA3s with the highest child mortality rates, 2011–2015 (%)

Broad cause of death	Armidale	Bourke - Cobar - Coonamble	Sydney Inner City	Orange	Taree - Gloucester	NSW
Natural	73.1	50.0	85.1	92.1	78.6	**75.9**
(Conditions arising in the perinatal period)	*(26.9)*	*(11.1)*	*(57.5)*	*(44.7)*	*(53.6)*	***(33.6)***
External	23.1	44.4	8.5	7.9	14.3	**16.0**
SIDS & other unknown	3.9	5.6	4.3	0.0	7.1	**6.6**
Pending	0.0	0.0	2.1	0.0	0.0	**1.6**
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

The variation in the cause of death distribution across these 5 SA3s highlights the importance of understanding the local context. For example:

- nearly all child deaths in the Orange SA3 were due to natural causes (92.1%), compared with half the child deaths in the Bourke - Cobar - Coonamble SA3, where there were nearly as many deaths from external causes (44.4%) as there were from natural causes (50.0%)
- over half the deaths in the Sydney Inner City SA3 were due to conditions arising in the perinatal period.

Change over time

Comparing figures 2.4, 2.5 and 2.6 provides a visual guide to changes in child mortality rates. However, it is also important to test whether the changes in child mortality rates, or the risk of death in each SA3, were significant.

A generalised linear model, Poisson regression, was used to test whether the changes over time in the observed mortality rates were significant in any SA3 or in New South Wales as a whole. The change in risk of dying was also estimated. As Poisson regression takes the number of deaths and the population sizes into account rather than just the mortality rates, it is a more suitable method than, for example, linear regression for analysing data consisting of counts of deaths in areas with variable population sizes.

The analysis found that:

- child mortality rates at the New South Wales level decreased significantly over this period, at a rate of approximately 2% a year
- no SA3 had a significant increase in its child mortality rate
- 18 SA3s had a significant reduction in their child mortality rates (Table 2.8)
- the areas with a significant decline in their mortality rates include small metropolitan SA3s as well as larger SA3s in more regional areas.

Table 2.8: SA3s with a significant decline in their child mortality rates

Name	Average decline per 3 year period (%)	Average annual decline (%)
Snowy Mountains	51	17
Tumut - Tumbarumba	39	13
Manly	31	10
Wollondilly	26	9
Eastern Suburbs - North	24	8
Dapto - Port Kembla	20	7
Marrickville - Sydenham - Petersham	21	7
Eastern Suburbs - South	21	7
Goulburn - Yass	18	6
North Sydney - Mosman	18	6
Lachlan Valley	16	5
Wollongong	14	5
Baulkham Hills	14	5
Gosford	11	4
Wyong	11	4
Bankstown	11	4
Canterbury	13	4
Merrylands - Guildford	10	3
NSW	**7**	**2**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW. The analysis used counts of deaths and numbers of children in five sets of 3-year time periods (2001–2003, 2004–2006, 2007–2009, 2010–2012, 2013–2015).

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Key findings—child mortality rates

- The gap in child mortality rates between areas narrowed over time.
- The SA3 with the highest child mortality rate was Armidale, followed by Bourke - Cobar - Connamble, Sydney Inner City, Orange, and Taree - Gloucester (2011–2015).
- The SA3 with the lowest child mortality rate was Manly, followed by Queanbeyan, Upper Murray exc. Albury, Pennant Hills - Epping, Wollondilly[10] (2011–2015).
- The child mortality rate in the Armidale SA3 was 4.5 times as high as the child mortality rate in the Manly SA3.
- No SA3 had a significant increase in its child mortality rate between 2001 and 2015, and there was a significant decrease in child mortality rates in 18 SA3s.

[10] There were also 3 SA3s where child mortality rates could not be calculated because there were fewer than 5 deaths: Snowy Mountains, Dural - Wisemans Ferry and Tumut - Tumbarumba.

3 Geographic distribution of infant deaths

This chapter focuses specifically on the distribution of infant deaths across New South Wales. As shown in Box 3.1, infant deaths represent the majority of child deaths in New South Wales (approximately 60%). Understanding their causes and distribution across the state can assist with targeting programs, services and interventions where they may have the greatest impact.

Box 3.1: Characteristics of infant deaths in New South Wales, 2010–2014

- There were 1,672 infants who died before their first birthday. This represents 61.9% of all child deaths during this period.
- Over one-tenth of deaths were to Aboriginal and Torres Strait Islander babies (11.1%).
- Nearly one-fifth of deaths were to babies with a child protection history (17.0%). Nine (9) babies were in care when they died.
- Ten (10) of the 1,672 deaths were to infants from *Remote* or *Very remote* areas; 74.3% were to babies in *Major cities*, 19.3% in *Inner regional* areas, and 5.9% in *Outer regional* areas.
- Just over 40% of infant deaths occured on the day of birth (41.6%); another 18.9% occured between 1 day and before 1 week after birth, and 12.7% occured between 1 week and 27 days after birth. In total, this represents 73.2% of deaths occurring in the neonatal period.
- The majority of infant deaths were attributable to natural causes (86.8%). This includes 52.9% to conditions originating in the perinatal period, 24.8% to congenital and chromosomal conditions, and 2.5% to conditions of the nervous system. Another 10.2% were from SIDS and other unknown causes, and 2.3% were from external causes.
- The CDRT classified 246 infant deaths (14.7%) as SUDI deaths. These include deaths from SIDS and other unknown causes, as well as those from sleep-related accidents (such as accidental suffocation).

Number of infant deaths

SA3-level counts highlight the geographic areas with the highest numbers of infant deaths. From a policy perspective, this information is crucial for identifying individual areas (or groups of areas) for further detailed analysis and program/service development to reduce the risk of infant deaths.

Variation across areas

Table 3.1 illustrates the extent of the area-level variation in the number of infant deaths in 2005–2009 and 2010–2014.[11] The average number of infant deaths per SA3 declined from 22 in 2005–2009 to 19 in 2010–2014, while the lowest number of infant deaths in an area declined from 2 in 2005–2009 to 0 in 2010–2014. The maximum number of deaths in an area also declined, from a high of 80 in 2005–2009 to a high of 60 in 2010–2014.

Table 3.1: Number of infant deaths, by SA3 and time period, descriptive statistics

Statistic	2005–2009	2010–2014
Mean	22	19
Median	18	16
Standard deviation	16.0	13.7
Minimum	2	0
Maximum	80	60
Number of SA3s with valid data[(a)]	88	88
Total number of infant deaths in NSW	**1,900**	**1,672**

(a) SA3s with at least 100 live births.

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

The distribution of infant deaths across New South Wales is shown in choropleth maps in Figure 3.1 (2005–2009) and Figure 3.2 (2010–2014). Darker blues represent higher numbers of infant deaths.

The data in the maps show that:

- the number of SA3s with fewer than 10 infant deaths decreased slightly, from 24 in 2005–2009 to 20 in 2010–2014
- the number of SA3s with more than 40 infant deaths decreased from 13 in 2005–2009 to 8 in 2010–2014
- in 2010–2014, 7 of the 8 SA3s with more than 40 infant deaths were concentrated in the greater Sydney region (the 8th is Newcastle).

[11] When this analysis was performed, live births at the SA3 level (which form the denominator for the infant mortality rates) were available only from 2001–2014. The infant deaths data are thus aggregated differently from those of the child deaths (2001–2004, 2005–2009, 2010–2014). That is, the first period consists of only 4 years of aggregated data, not 5 years. For this reason, the earlier period is excluded from the information on the counts of infant deaths. However, it is included in discussions of infant mortality rates.

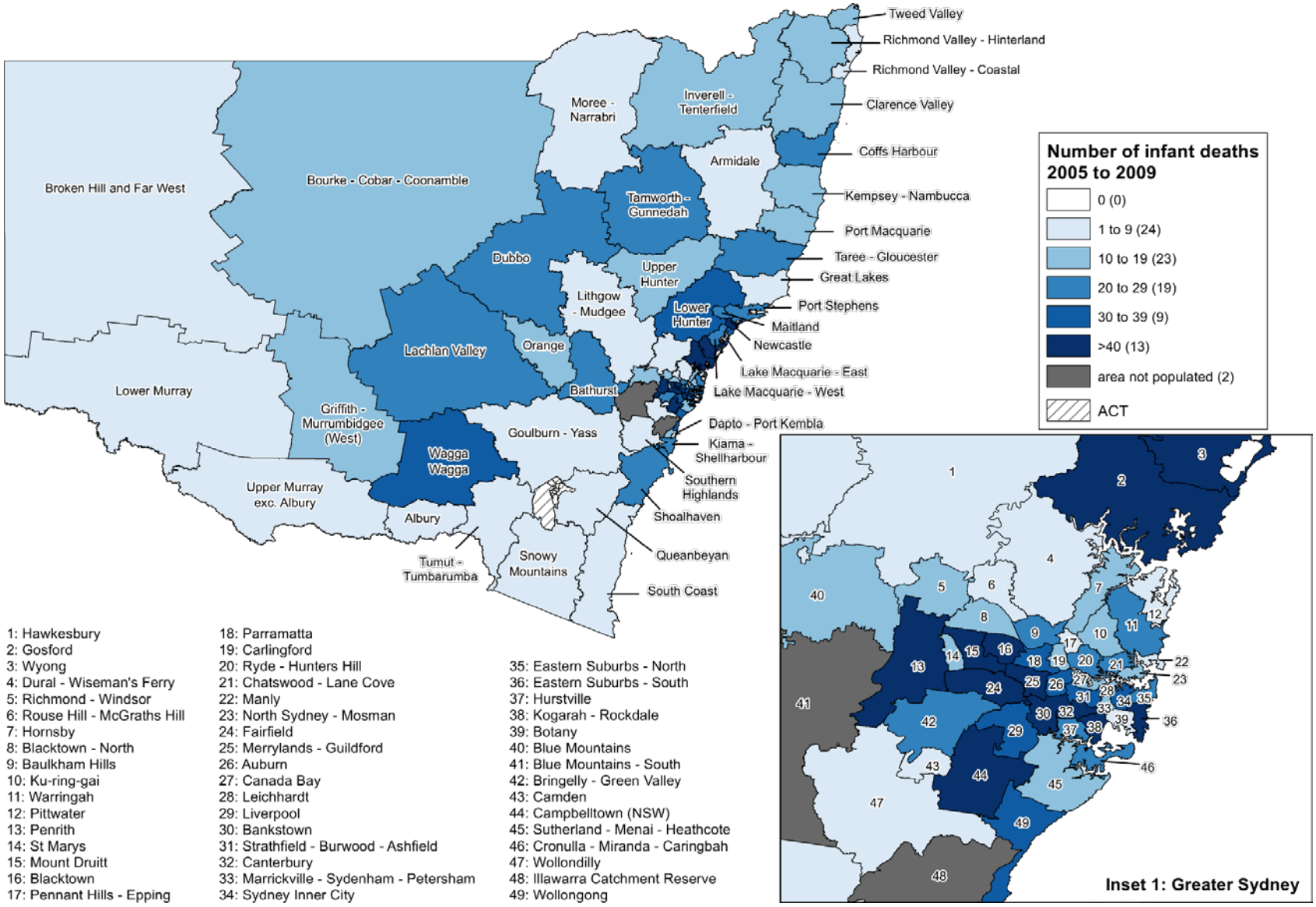


Figure 3.1: Number of infant deaths in NSW, by SA3 of residence, 2005–2009

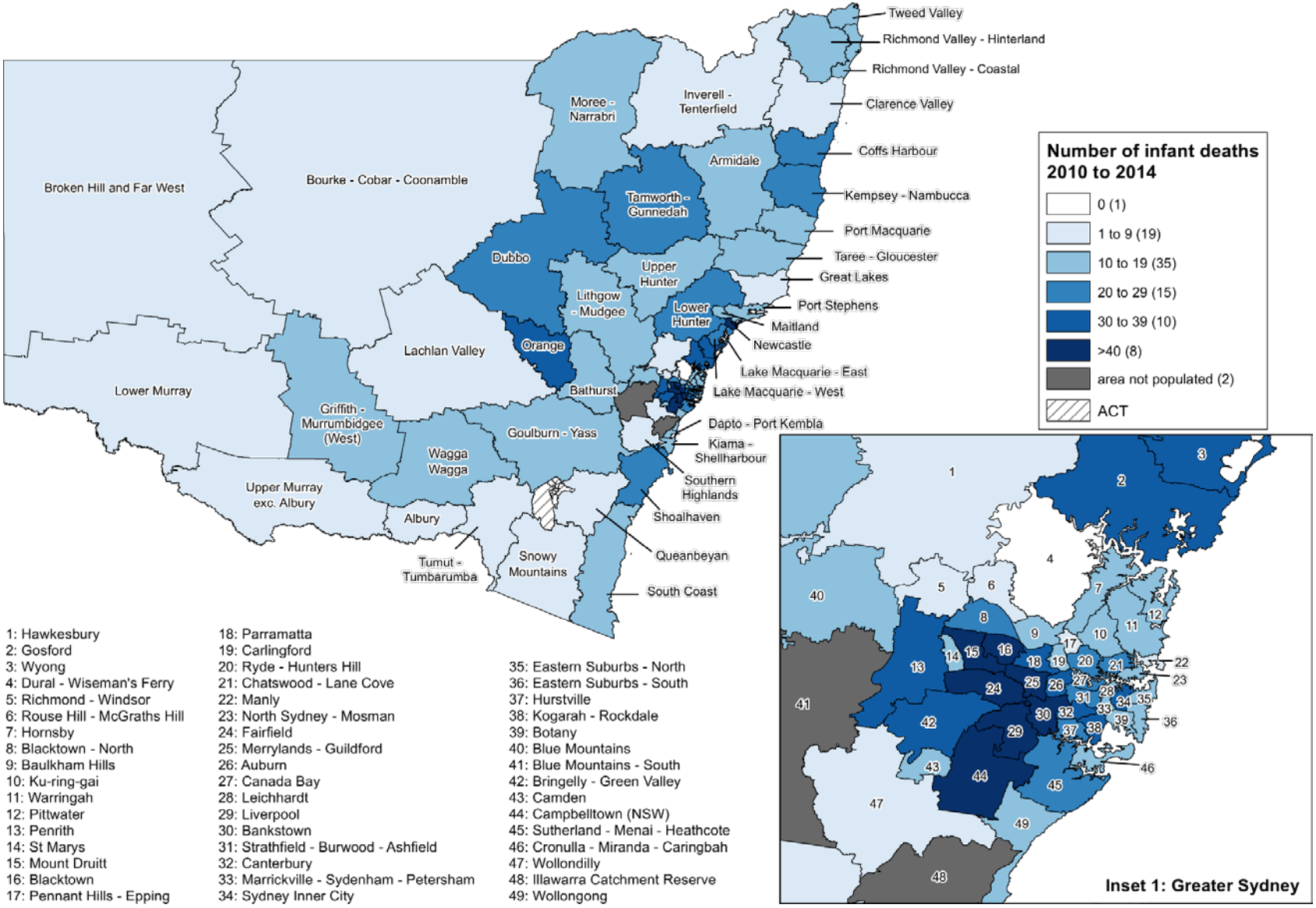


Figure 3.2: Number of infant deaths in NSW, by SA3 of residence, 2010–2014

Table 3.2 presents the 5 SA3s with the highest number of infant deaths in each period and each area's infant mortality rate. The areas in Table 3.2 are similar to those in Table 2.2 in Chapter 2 (child deaths), and highlight the fact that infant deaths make up a large percentage of all child deaths.

Table 3.2: The 5 SA3s with the highest number of infant deaths, 2005–2009 and 2010–2014

2005–2009			2010–2014		
SA3	**Infant deaths**	**Infant mortality rate**	**SA3**	**Infant deaths**	**Infant mortality rate**
Campbelltown (NSW)	80	5.1	Campbelltown (NSW)	60	5.1
Mount Druitt	61	5.7	Mount Druitt	55	5.7
Bankstown	58	3.2	Blacktown	52	4.8
Penrith	56	3.0	Fairfield	50	3.7
Newcastle	55	4.0	Merrylands - Guildford	50	4.1
NSW total	**1,900**	**4.0**	**NSW total**	**1,672**	**3.4**

Note: In 2010–2014, Dural - Wisemans Ferry had no infant deaths, and there were 9 areas in which rates could not be calculated because there were fewer than 5 deaths: Broken Hill and Far West, Hawkesbury, Lower Murray, Manly, Pennant Hills - Epping, Queanbeyan, Snowy Mountains, Tumut - Tumbarumba, Upper Murray exc. Albury.

Source: AIHW analysis of NSW CDRT.

Table 3.2 shows that:

- Campbelltown and Mount Druitt had the highest number of infant deaths in both periods, while the next three areas change depending on the period
- except for Newcastle in 2005–209, the 5 SA3s with the highest numbers of child deaths are all in Southwest and Western Sydney
- the 5 SA3s combined accounted for 16% of all infant deaths in New South Wales in each period.

Characteristics of infant deaths in the areas with the highest numbers

Table 3.3 includes some high-level information about the infant deaths that occurred in the 5 SA3s with the highest numbers of infant deaths. It includes the percentage of infants who died in the neonatal period (before 28 days after birth), the percentage who died from natural causes (with the percentage who died from conditions arising in the perinatal period highlighted), and the percentage who died from SIDS and other undetermined causes.

Table 3.3: Percentage distribution of the timing of death and cause of death in the 5 SA3s with the highest numbers of infant deaths, 2010–2014

	%					
Characteristic	**Campbelltown**	**Merrylands - Guildford**	**Mount Druitt**	**Fairfield**	**Blacktown**	**NSW**
Neonatal deaths (before 28 days)	80.0	74.5	76.9	78.0	82.0	73.2
Cause of death						
Natural causes	91.7	80.0	90.4	94.0	92.0	86.8
(*Conditions arising in the perinatal period)*	*(65.0)*	*(57.4)*	*(65.9)*	*(50.0)*	*(56.0)*	*(52.9)*
SIDS and other undetermined	8.3	16.7	9.6	4.0	6.0	10.2
All other causes	0.0	3.3	0.0	2.0	2.0	3.0

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

The findings show that, in 2010–2014:

- the percentage of infants who died in the neonatal period was higher for all 5 SA3s than in the state as a whole, with 82.0% of infant deaths in Blacktown and 80.0% of infant deaths in Campbelltown occurring in the neonatal period
- two-thirds of infant deaths in Campbelltown and Mount Druitt were attributable to conditions arising in the perinatal period
- the percentage of infant deaths from SIDS and other undetermined causes was lower than the state average in 4 of the SA3s. In Merrylands - Guildford, however, 16.7% of infant deaths were from SIDS and other undetermined causes.

Number of sudden unexpected deaths in infancy

SUDI is the death of an infant aged under 12 months that is sudden and unexpected, where the cause was not immediately apparent at the time of death. It is not a cause of death *per se*, but a category of deaths. Between 2010 and 2014, there were 246 SUDI deaths across New South Wales.

Previous work by the CDRT and the AIHW has shown that SUDI deaths disproportionately affect infants in disadvantaged areas and vulnerable families (NSW CDRT 2014, 2016a). Spatial analyses can help identify if there are geographic areas where targeting interventions to offset modifiable risk factors might help reduce these deaths. Modifiable risk factors include the sleep environment (such as bedding, sleep position, where the baby sleeps) as well as exposure to environmental tobacco smoke.

In all but 19 SA3s, there were too few SUDI deaths to calculate SUDI-specific infant mortality rates, so data is presented on the number of SUDI deaths. Figure 3.3 presents a map of the number of SUDI deaths in 2010–2014. It shows that:

- there were 18 SA3s with no SUDI deaths, and another 53 SA3s with between 1 and 4 SUDI deaths
- there were 12 SA3s with 5 or more SUDI deaths, spread across metropolitan and regional areas. Mount Druitt had the highest number of SUDI deaths, with 11.

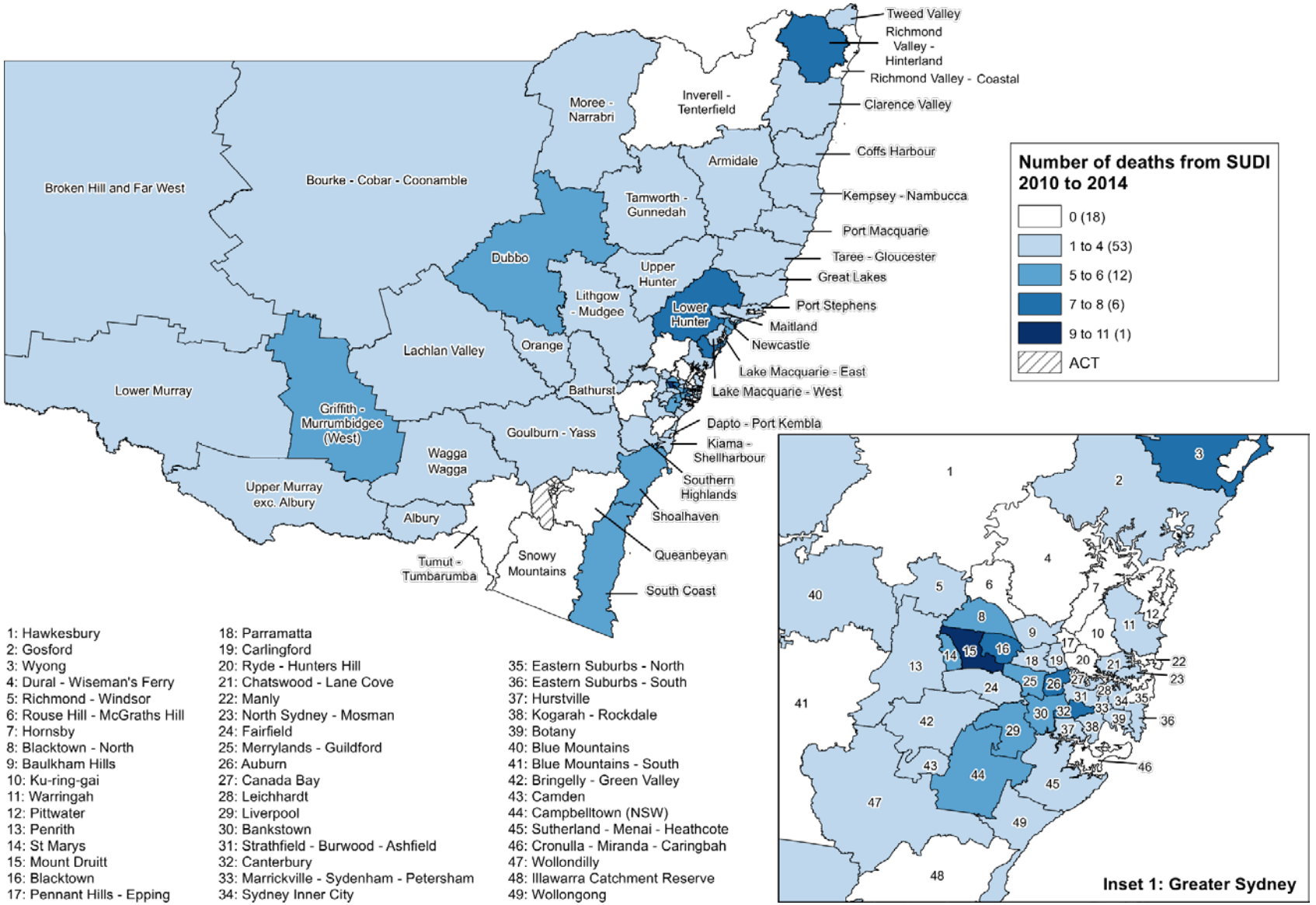


Figure 3.3: Number of infant deaths classified as SUDI in NSW, by SA3 of residence, 2010–2014

Key findings—number of infant deaths

- The number of SA3s with fewer than 10 infant deaths decreased slightly, from 24 in 2005–2009 to 20 in 2010–2014.
- The number of SA3s with more than 40 infant deaths decreased from 13 in 2005–2009 to 8 in 2010–2014.
- In 2010–2014, 7 of the 8 SA3s with more than 40 infant deaths were concentrated in the greater Sydney region (the 8th is Newcastle).
- The SA3 with the highest number of infant deaths in 2010–2014 was Campbelltown, followed by Merrylands - Guildford, Mount Druitt, Fairfield, and Blacktown.
- These 5 SA3s combined accounted for 16% of all infant deaths in New South Wales in 2010–2014.
- There were 18 SA3s with no SUDI deaths in 2010–2014, and another 53 with between 1 and 4 SUDI deaths.
- There were 12 SA3s with 5 or more SUDI deaths, spread across metropolitan and regional areas. Mount Druitt had the highest number of SUDI deaths, with 11.

Infant mortality rates

While the aggregate numbers of infant deaths are important, they do not illustrate how the *risk* of death during infancy varies across areas. This section presents the distribution of infant mortality rates across SA3s within New South Wales and information on the SA3s with the highest rates.

Variation across areas

SA3-level infant mortality rates were calculated for 2001–2004, 2005–2009 and 2010–2014. The variation in these area-level rates is shown in Table 3.4.

Table 3.4: Descriptive statistics, SA3-level infant mortality rates, by period

Statistic	2001–2004	2005–2009	2010–2014
Mean	4.75	4.03	3.61
Median	4.33	3.82	3.38
Standard deviation	1.85	1.41	1.29
Minimum	1.60	1.84	1.35
Maximum	12.22	8.48	7.53
Number of SA3s where rates could be calculated[1]	80	80	78
Total number of infant deaths	**1,482[2]**	**1,900**	**1,672**

Notes

1. SA3s with at least 100 live births and 5 deaths to children aged under 1. In 2010–2014, Dural - Wisemans Ferry had no infant deaths, and there were 9 areas in which rates could not be calculated because there were fewer than 5 deaths: Broken Hill and Far West, Hawkesbury, Lower Murray, Manly, Pennant Hills - Epping, Queanbeyan, Snowy Mountains, Tumut - Tumbarumba, Upper Murray exc. Albury.
2. Note that this period only has 4 years of data combined, not 5, so the total number of deaths is not comparable with the other two periods.
3. The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Table 3.4 shows that:

- the mean SA3-level infant mortality rate declined from 4.75 in 2001–2004 to 3.61 in 2010–2014
- the highest infant mortality rate in the earlier period was 12.22; by 2010–2014, the highest infant mortality rate was 7.53. Thus, there is much less variation between areas in more recent infant mortality rates than in the earlier periods (rate difference of 3.92 in 2010–2014, compared with 4.45 in 2005–2009 and 7.47 in 2001–2004).

The distribution of infant mortality rates across New South Wales is shown in Figure 3.4 (2001–2004), Figure 3.5 (2005–2009) and Figure 3.6 (2010–2014). Darker blues represent higher infant mortality rates. The ranges and colours are consistent between these maps.

The data in the maps show that:

- the number of SA3s with infant mortality rates under 4.0 increased from 29 in 2001–2004 to 44 in 2005–2009 to 53 in 2010–2014
- the number of SA3s with infant mortality rates of 8.0 or greater decreased from 5 in 2001–2004, to 1 in 2005–2009, and to 0 in 2010–2014
- there are 9 SA3s where rates could not be calculated because there were between 1 and 4 deaths. Eight (8) of those 9 areas are large regional SA3s; the other is Hawkesbury, on the edge of the Sydney metropolitan area.

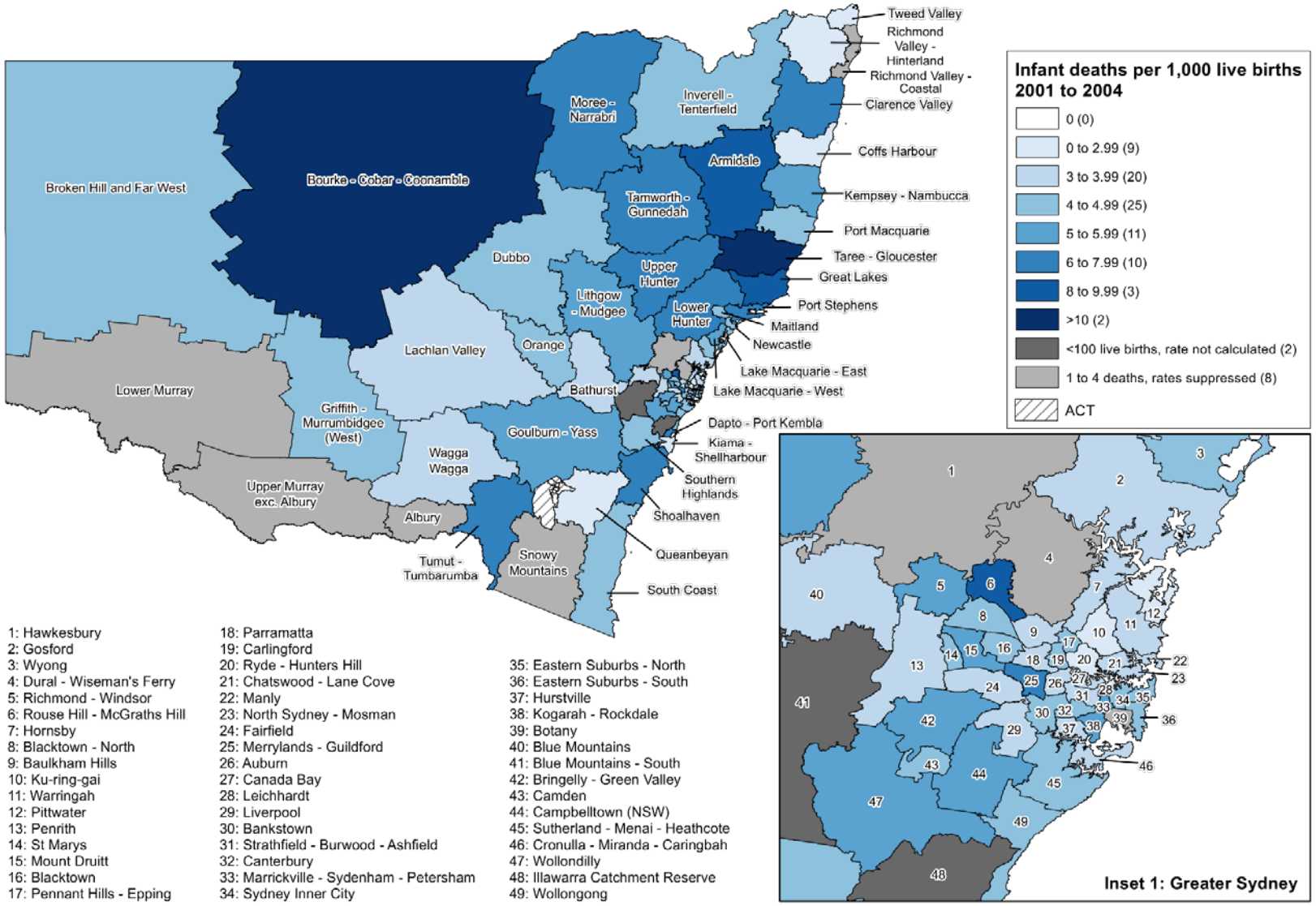


Figure 3.4: Infant mortality rates in NSW, by SA3 of residence, 2001–2004

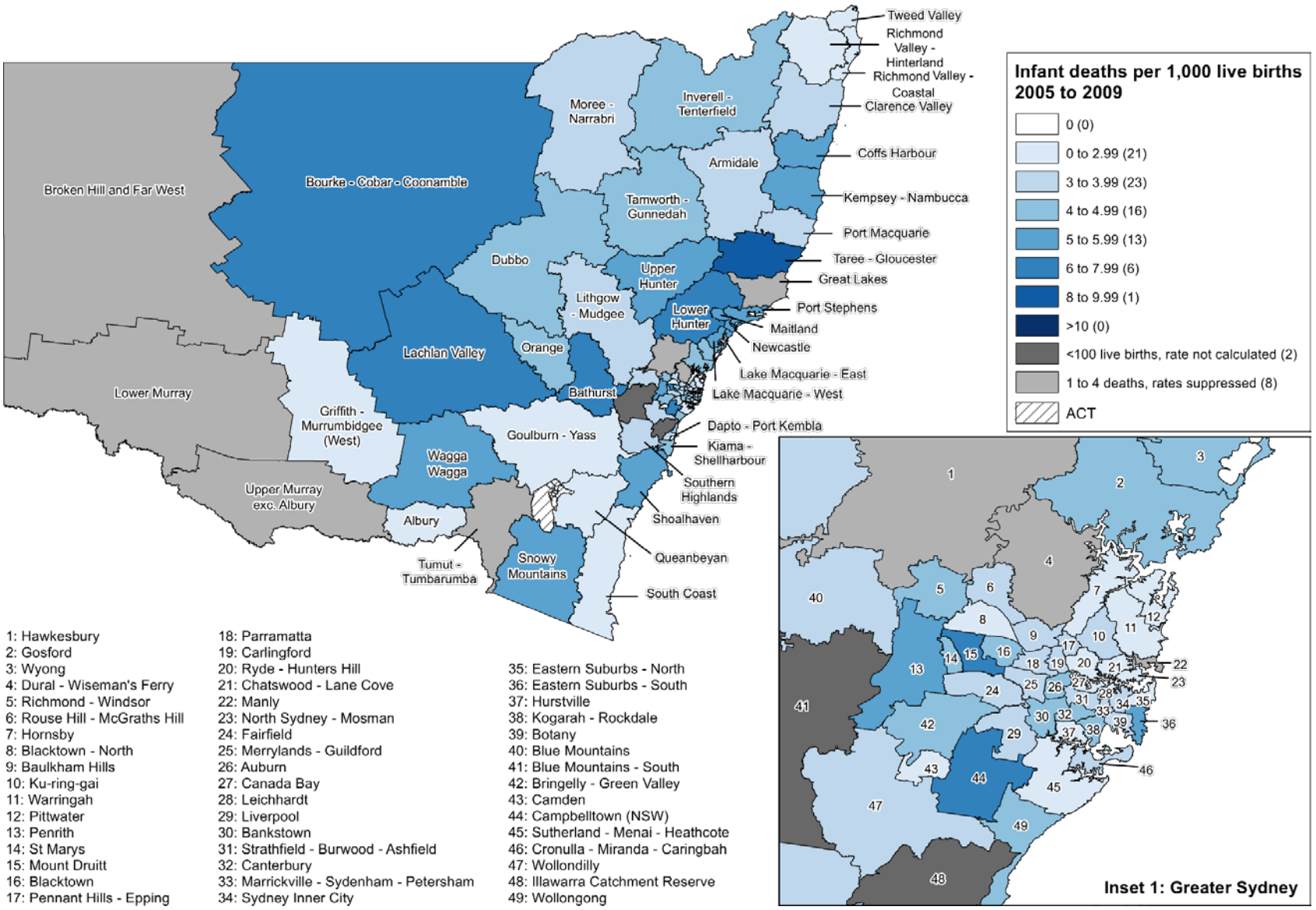


Figure 3.5: Infant mortality rates in NSW, by SA3 of residence, 2005–2009

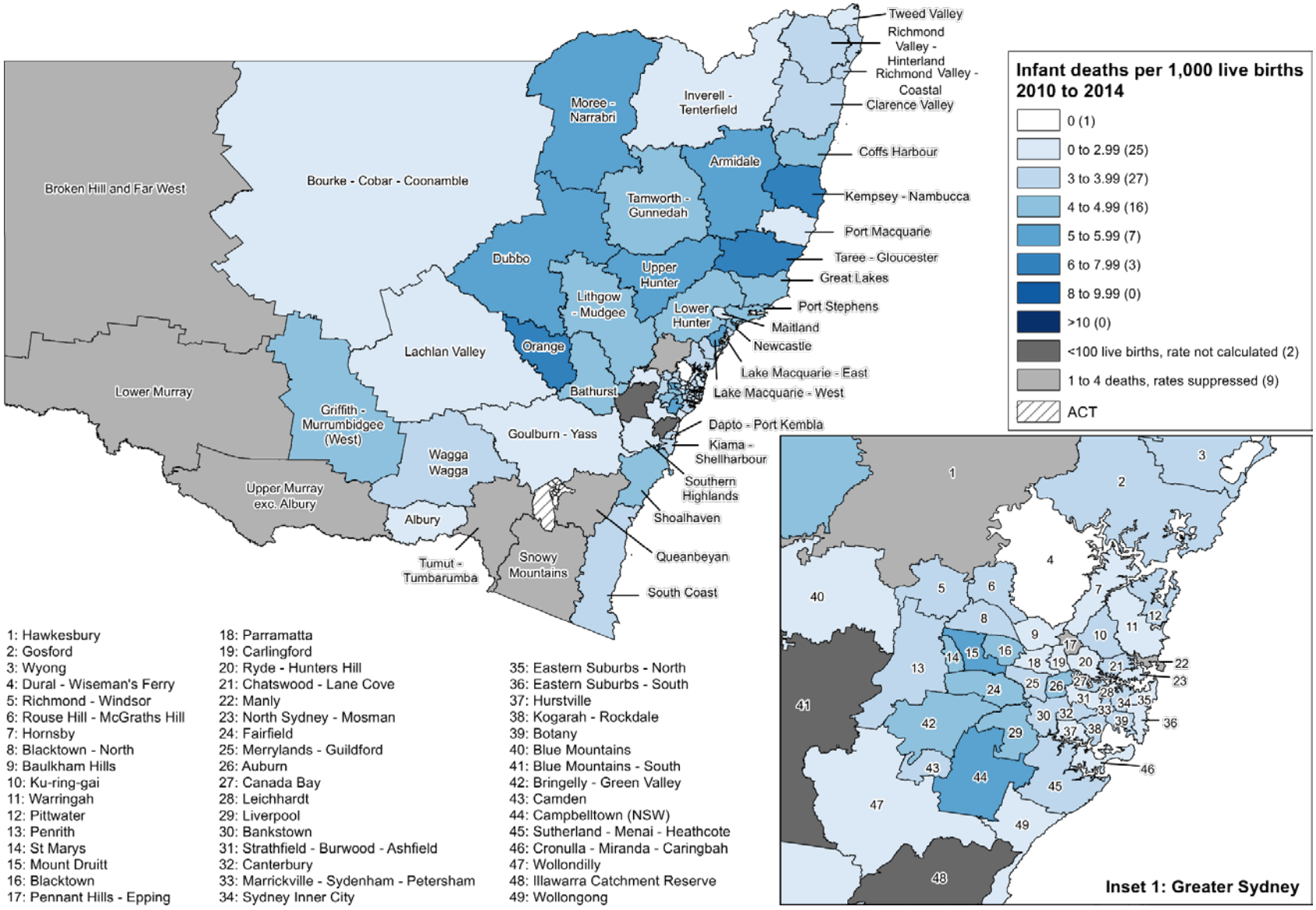


Figure 3.6: Infant mortality rates in NSW, by SA3 of residence, 2010–2014

Areas with the highest and lowest infant mortality rates

The 5 SA3s with the highest infant mortality rates in each period are presented in Table 3.5, and those with the lowest, in Table 3.6.

Table 3.5: The 5 SA3s with the highest infant mortality rates, by period

2001–2004			2005–2009			2010–2014		
SA3	IMR	Infant deaths	SA3	IMR	Infant deaths	SA3	IMR	Infant deaths
Taree - Gloucester	12.21	23	Taree - Gloucester	8.48	23	Orange	7.53	31
Bourke - Cobar - Coonamble	10.66	19	Bathurst	7.68	22	Kempsey - Nambucca	7.26	20
Great Lakes	8.55	<10	Lachlan Valley	7.52	28	Taree - Gloucester	7.14	19
Rouse Hill - McGraths Hill	8.44	11	Campbelltown	6.50	80	Upper Hunter	5.84	13
Armidale	8.06	14	Mount Druitt	6.34	61	Moree - Narrabri	5.74	13
NSW total	**4.34**	**1,482**	**NSW total**	**4.00**	**1,900**	**NSW total**	**3.43**	**1,672**

IMR = infant deaths/live births x 1,000.

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Table 3.6: The 5 SA3s with the lowest infant mortality rates, by period

2001–2004			2005–2009			2010–2014		
SA3	Mortality rate	Deaths	SA3	Mortality rate	Deaths	SA3	Mortality rate	Deaths
Tweed Valley	1.60	<10	Queanbeyan	1.84	<10	Dural - Wisemans Ferry	0.00	0
Leichhardt	1.84	<10	Pittwater	1.94	<10	Albury	1.35	<10
Queanbeyan	1.85	<10	Camden	2.01	<10	Warringah	1.65	17
Richmond Valley - Hinterland	2.56	<10	Albury	2.13	<10	North Sydney - Mosman	1.85	13
Kiama - Shellharbour	2.73	11	Tweed Valley	2.14	10	Eastern Suburbs - South	1.87	18
NSW total	**4.34**	**1,482**	**NSW total**	**4.00**	**1,900**	**NSW total**	**3.43**	**1,672**

IMR = infant deaths/live births x 1,000.

Note: In 2010–2014, there were 9 areas in which rates could not be calculated because there were fewer than 5 deaths: Broken Hill and Far West, Hawkesbury, Lower Murray, Manly, Pennant Hills - Epping, Queanbeyan, Snowy Mountains, Tumut - Tumbarumba, Upper Murray exc. Albury.

Source: AIHW analysis of NSW CDRT.

The results show that:

- areas with high infant mortality rates do not necessarily have a relatively large number of infant deaths. Except for Campbelltown and Mount Druitt in 2005–2009, there is no overlap between the SA3s with the highest number of infant deaths and the highest infant mortality rates

- in 2010–2014, the 5 SA3s with the highest infant mortality rates accounted for 5.7% of all infant deaths in New South Wales
- in 2010–2014, the infant mortality rate in the Orange SA3 was 5.6 times as high as the lowest infant mortality rate that could be calculated (1.35 in Albury).

Causes of death in the areas with the highest infant mortality rates

A high-level overview of the cause of death distribution in the 5 SA3s with the highest infant mortality rates in 2010–2014 is presented in Table 3.7.

Table 3.7: Percentage distribution of the timing and cause of death in the 5 SA3s with the highest infant mortality rates, 2010–2014

	%					
Characteristic	**Orange**	**Kempsey-Nambucca**	**Taree - Gloucester**	**Upper Hunter**	**Moree - Narrabri**	**NSW**
Neonatal deaths (before 28 days)	83.4	85.0	84.2	84.6	53.8	**73.2**
Cause of death[(a)]						
Natural causes	93.5	80.0	94.7	76.9	84.6	**86.8**
(*Conditions arising in the perinatal period)*	*(58.1)*	*(55.0)*	*(73.7)*	*(61.5)*	*(38.5)*	***(52.9)***
All other causes	6.5	20.0	5.3	23.1	15.4	**13.2**

(a) Because of the small number of deaths in each area, only these broad causes can be shown.

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

The findings show that:

- the percentage of infants who died in the neonatal period was higher for 4 of the 5 SA3s than for New South Wales as a whole. However, in Moree - Narrabri, 46.2% of infant deaths occurred after 28 days
- a lower proportion of infant deaths in the Upper Hunter and Kempsey - Nambucca SA3s were due to natural causes than in the other 3 SA3s and in New South Wales as a whole
- nearly two-thirds (73.7%) of infant deaths in Taree - Gloucester were attributable to conditions arising in the perinatal period.

Change over time

The maps in this chapter highlight broad changes in infant mortality rates over the three periods for each of the SA3s. As in Chapter 2, however, a more rigorous statistical analysis was performed to examine whether changes over time in the observed rates were significant.

The results from the Poisson regression models showed that:

- infant mortality rates at the New South Wales level decreased significantly over this period, at a rate of approximately 3% a year
- no SA3 had a statistically significant increase in its infant mortality rate
- 13 SA3s had a statistically significant decrease in their infant mortality rate (Table 3.8).

Comparing the areas with significant changes in their infant mortality rates (Table 3.8) with the areas with significant changes in their child mortality rates (Table 2.8) shows that there is overlap in 7 of the SA3s. That is, of the 18 SA3s with significant declines in child mortality rates, 7 had a decrease in their infant mortality rates.

Table 3.8: SA3s with a significant decline in their infant mortality rates

Name	Average decline per 3-year-period (%)	Average annual decline (%)
Manly	40	13
Bourke - Cobar - Coonamble	33	11
Goulburn - Yass	28	9
Eastern Suburbs - South	28	9
Clarence Valley	24	8
Eastern Suburbs - North	24	8
Dapto - Port Kembla	23	8
Maitland	21	7
North Sydney - Mosman	21	7
Warringah	19	6
Wollongong	18	6
Lower Hunter	15	5
Merrylands - Guildford	15	5
NSW	**8**	**3**

Note: The table includes only those deaths where the children's residential address was in NSW at the time of their death and could be geocoded, and where the death occurred in NSW. The analysis used counts of infant deaths and numbers of live births in five sets of time periods (2001–2002, 2003–2005, 2006–2008, 2009–2010, 2011–2014).

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Key findings—infant mortality rates

- There is much less variation between areas in infant mortality rates in more recent times than in the earlier periods.
- The SA3 with the highest infant mortality rate in 2010–2014 was Orange, followed by Kempsey - Nambucca, Taree - Gloucester, Upper Hunter, and Moree - Narrabri.
- The SA3 with the lowest infant mortality rate in 2010–2014 was Dural - Wisemans Ferry, followed by Albury, Warringah, North Sydney - Mosman, and Eastern Suburbs - South. An additional 9 SA3s had between 1 and 4 infant deaths, so their infant mortality rates could not be calculated.
- In 2010–2014, the infant mortality rate in the Orange SA3 was 5.6 times as high as the lowest infant mortality rate that could be calculated (1.35 in Albury).
- No SA3 had a significant increase in its infant mortality rate over the period, and 13 SA3s had a significant decrease in their infant mortality rate.

4 Variations in child mortality by area-level characteristics

This chapter focuses on how the risk of child death varies by area-level characteristics. It builds on previous work, which has shown that child mortality rates are higher in areas of greater socioeconomic disadvantage, in areas with higher levels of child social exclusion, and in more remote areas (AIHW 2014, 2017; NSW CDRT 2016a). The analysis centres on 4 domains:

- Socioeconomic context
- Social capital
- Housing
- Child health and development.

The chapter begins with a conceptual framework and discussion of how contextual variables relate to the risk of child mortality, then presents the findings.

Conceptual framework

According to the World Health Organization, the social conditions in which people are born, live and work is the single most important determinant of good or poor health (cited in AIHW 2016). Factors such as economic opportunities, social context (such as social capital/social inclusion), service availability, the built environment (such as housing, walkability) and environmental factors (such as air quality) convey advantages to some areas and disadvantages to others. These advantages and disadvantages are then reflected in what is known as the social gradient of health, whereby those with better access to social, cultural, economic and health resources have better health.

How these characteristics are linked with infant and child death is shown in Figure 4.1.

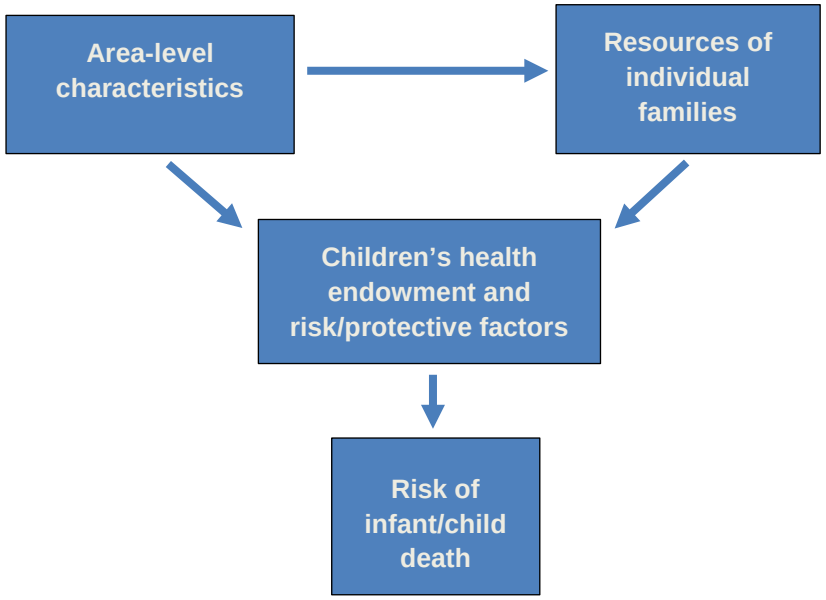


Figure 4.1: Conceptual overview of how area-level characteristics affect child mortality

Contextual variables can have both indirect and direct effects on child mortality. At one level, contextual factors work indirectly through the resources of individual families, which affects the extent to which children are exposed to risky or protective environments. For example, families with poorer access to social and economic resources are more likely to live in poorer housing, to have higher rates of behavioural and psychosocial risk factors and lower levels of health literacy and engagement with the health system, and generally to have poorer access to health services.

This, in turn, affects the risk of infant and child death at the individual level, with higher risks for those with poorer health endowments (for example, those with chronic conditions, those who were born with congenital or chromosomal conditions and those who were pre-term or small-for-gestational age). It is also higher for those who are not immunised, those who are exposed to environmental tobacco smoke, those living in poorer quality or overcrowded housing, and those with a child protection history (AIHW 2016, 2017; Moore et al. 2014).

Area-level characteristics may also have direct effects on children's health that work outside family characteristics. These include factors such as air quality, the availability of health services, and the quality of roads or the availability of public transport services.

Domains and variables

Table 4.1 includes an overview of the included domains and the variables (more detailed information on the variable definitions, data sources and distribution of the values is presented in Appendix Table B4, Table B5a and Table B5b).

Three (3) of the domains capture various aspects of area-level advantage and disadvantage (economic context, social capital, housing), while the fourth reflects compositional differences between areas in child health and development.

Table 4.1: Overview of domains, relationship with child mortality, and included indicators

Domain	Importance/relationship	Indicators
Economic context	There is a strong relationship between area-level indicators of socioeconomic status and mortality (social gradient of health). Those in areas with fewer economic resources have higher rates of illness, behavioural risk factors and poorer access to health services.	SEIFA IRSD Unemployment rate Poverty rate Percentage who would have difficulty accessing funds in an emergency
Social capital	Social capital is a protective factor associated with greater social and community support, community safety and cohesion, and participation in education, sport and voluntary work.	Percentage of adults volunteering Educational attainment (Year 12) Educational engagement (16-year-olds)
Housing	Safe, affordable and appropriate housing is a key element of children's health and wellbeing. There are health risks from overcrowded and unsafe housing; in areas with high levels of mortgage and/or rental stress, families may have fewer economic resources for other expenses.	Percentage of households that are overcrowded Rental stress Percentage of housing rented from the government
Child health and development	Children with identified health issues or physical or developmental vulnerabilities are at higher risk of death.	Percentage of children in each area assessed as developmentally vulnerable on 2 or more of the 5 domains of the AEDC

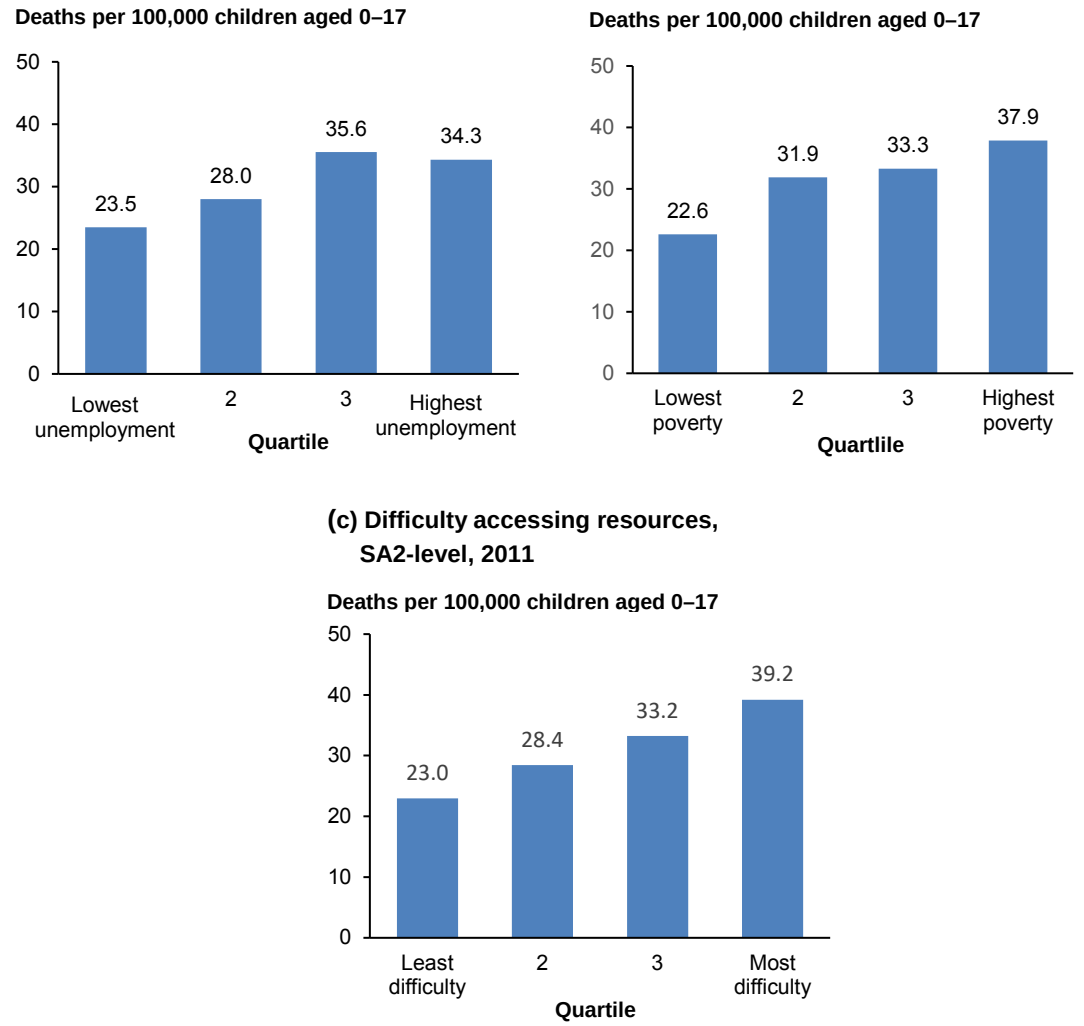
It is important to note that these domains and the included variables reflect the broad characteristics of the areas; it cannot be assumed that all individual children or families in an area will share those same characteristics.

Findings

The following sections illustrate how mortality rates vary by the area-level characteristics outlined in Table 4.1.

Economic context

Figure 4.2 shows child mortality rates by three measures of economic disadvantage (unemployment rates, poverty rates, and perceived difficulty in accessing resources in an emergency).



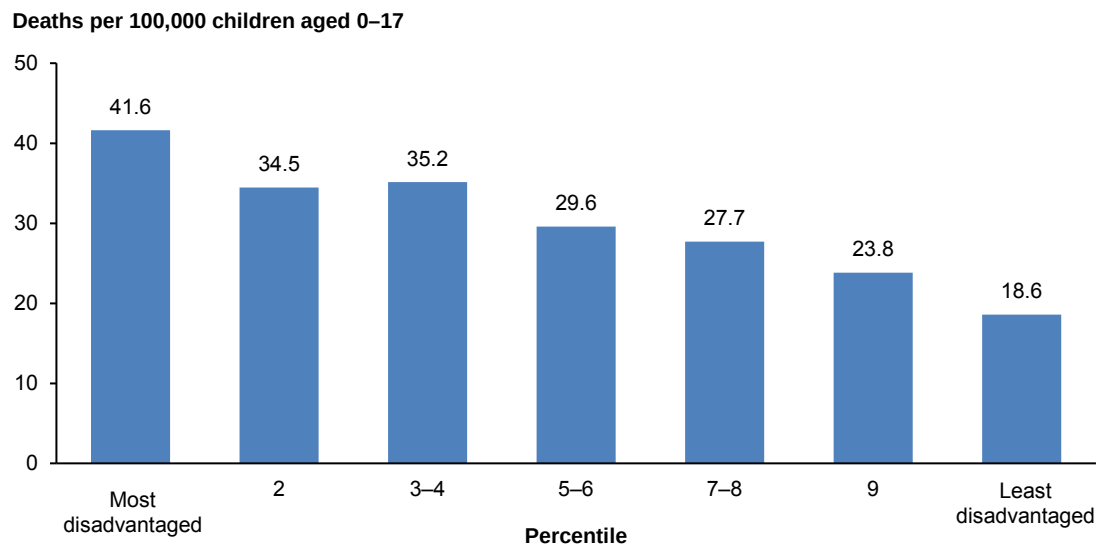
Note: Definitions and data sources for the contextual variables are in Appendix Table B3.

Source: AIHW analysis of NSW CDRT data.

Figure 4.2: Child mortality rates, by measures of economic context, NSW, 2011–2015

Across all these indicators the pattern is clear: the risk of dying during childhood is lowest for children living in more economically advantaged areas, and highest for children living in the most disadvantaged areas. For example, the child mortality rate for those living in the areas with the lowest poverty rates is 22.6 deaths per 100,000 children aged 0–17. This is 15.3 deaths per 100,000 fewer than the mortality rate for children living in the areas with the highest poverty rates (rate difference). Children living in areas with the highest poverty rates are 1.7 times as likely to die as those living in areas with the lowest poverty rates (rate ratio).

The CDRT (2016a) and the AIHW (2017) regularly report child mortality rates by quintiles of the IRSD. Figure 4.3 disaggregates the IRSD further into deciles in order to look at how those in areas of extreme disadvantage (the bottom 10% of IRSD scores) compare with those in areas with the least disadvantage (the top 10% of IRSD scores). It shows that children who live in the most disadvantaged areas are 2.2 times as likely to die during childhood as those living in the least disadvantaged areas, with a difference of 23.0 deaths per 100,000 children.

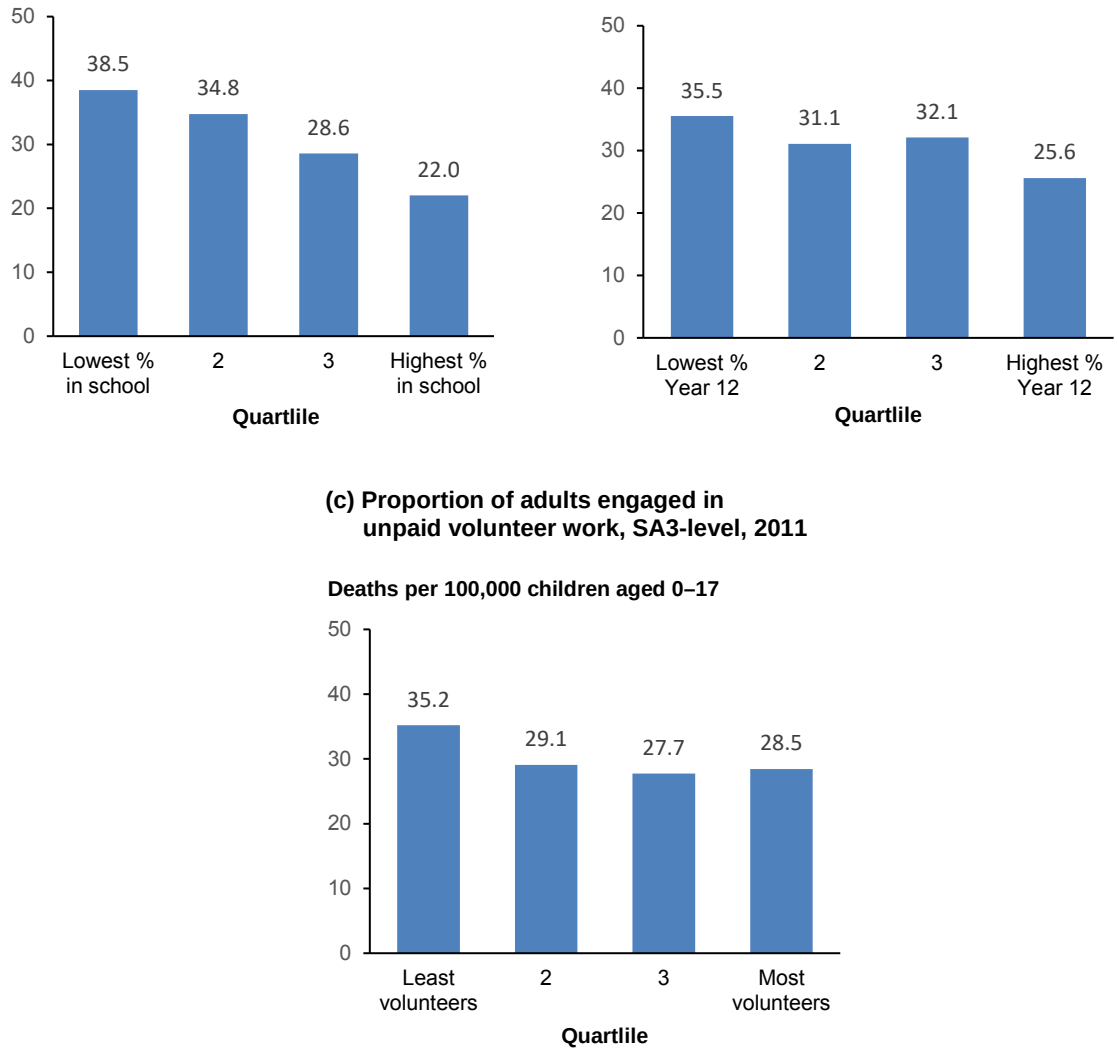


Source: AIHW analysis of NSW CDRT data.

Figure 4.3: Child mortality rates, by 2011 SA2-level SEIFA IRSD score, NSW 2011–2015

Social capital

Education is important not just for its relationship to income and employment opportunities, but also because of its broader impacts (such as health literacy). Figure 4.4 shows that there is a strong relationship between the two included area-level measures of education and child mortality rates: current engagement in education (percentage of 16-year-olds currently in school) and the percentage of the population aged 25–54 who completed Year 12. Another measure of social capital is the percentage of adults engaged in volunteer work. Figure 4.4 also shows that child mortality rates are highest in areas where the fewest adults volunteer (35.2 per 100,000), but there is little difference between the other areas.



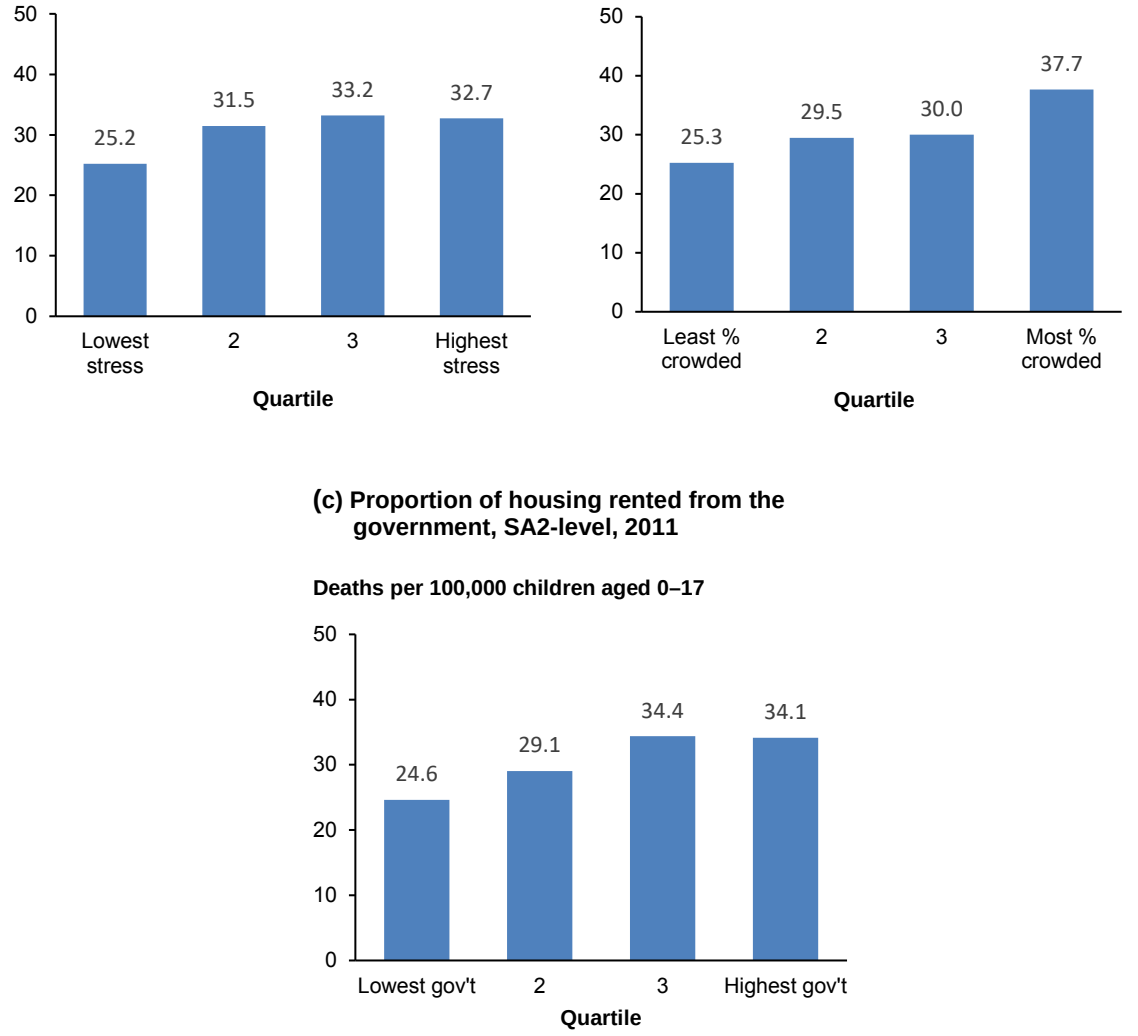
Note: Definitions and data sources for the contextual variables are in Appendix Table B3.

Source: AIHW analysis of NSW CDRT data.

Figure 4.4: Child mortality rates, by measures of social capital, NSW, 2011–2015

Housing

Ideally, the project would have been able to capture individual-level measures of the quality of housing in which children live, the extent of overcrowding, and the cost of housing relative to parental or family income. However, Figure 4.5 shows that, even at an aggregate level, areas with higher levels of overcrowded housing, higher rates of government housing and higher rental stress all have higher child mortality rates. While these variables are measures of housing, they are also strongly correlated with economic context. It is important to emphasise that these are associations, not causal relationships.



Note: Definitions and data sources for the contextual variables are in Appendix Table B3.

Source: AIHW analysis of NSW CDRT data.

Figure 4.5: Child mortality rates, by housing measures, NSW, 2011–2015

Child health and development

The AEDC, formerly known as the Australian version of the Early Development Instrument (AEDI), is a nationwide data collection of early childhood development which collects data on five key areas of early childhood development, referred to as 'domains':

- Physical health and well being
- Social competence
- Emotional maturity
- Language and cognitive skills
- Communication skills and general knowledge.

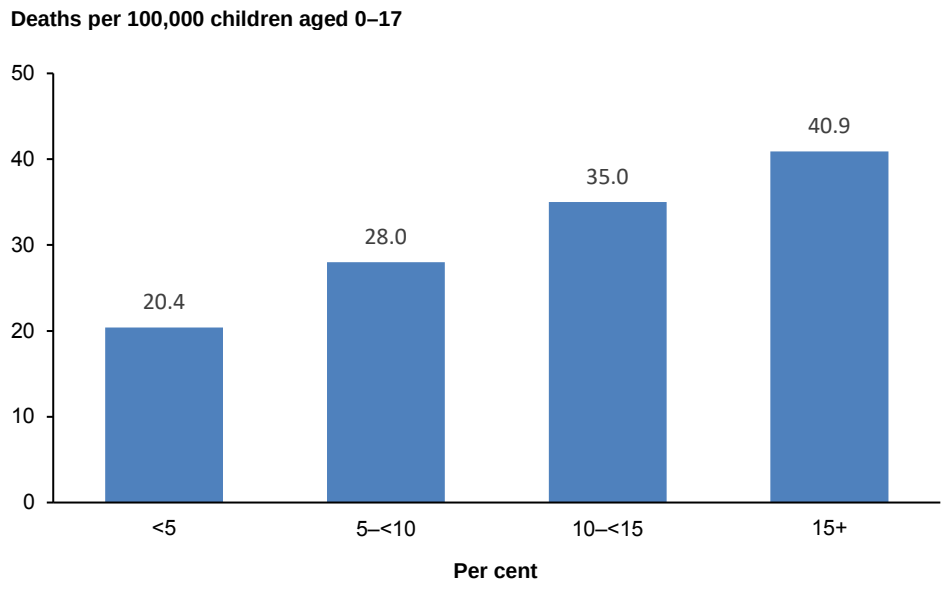
Teachers of children in their first year of full-time school complete the instrument, and the data are collected every 3 years (the most recent collection was in 2015). The results can be used to support health, education and community policy and planning at local levels by highlighting areas of strengths and vulnerabilities among children beginning their schooling journeys.

Vulnerability on each domain is defined as being in the bottom 10% of scores for that domain (that is, it is a relative measure, not an absolute measure). Children who are developmentally vulnerable on 2 or more domains are considered to be at particularly high risk.

Geographic areas with high rates of developmental vulnerability may be more likely to have higher child death rates, as the factors that underpin developmental vulnerability may be similar to those that underpin the risk of death during childhood.

The SA2 with the lowest percentage of developmentally vulnerable children was Darlinghurst (1.19%), while the highest was Wellington (31.78%). The mean value was 9.63%, with a standard deviation of 3.94 (Table B6).

Figure 4.6 shows that child mortality rates in 2011–2015 were approximately twice as high in areas with high levels of developmental vulnerability compared with those where less than 5% of children were developmentally vulnerable (40.9 deaths per 100,000 children compared with 20.4 deaths per 100,000). The difference between these areas is 20.5 deaths per 100,000.



Source: AIHW analysis of NSW CDRT data.

Figure 4.6: Child mortality rates, by percentage vulnerable on two or more domains of the AEDC (SA2 level), NSW 2011–2015

This pattern holds across broad cause of death categories, with children in areas with higher levels of developmental vulnerability having higher rates of deaths from both natural and external causes (Table 4.3). Rates of SIDS and other undetermined deaths are also higher.

Table 4.3: Child mortality rates by SA2 level of developmental vulnerability and broad cause of death category, NSW 2011–2015

SA2 level percentage of children vulnerable on 2 or more domains of the AEDC	Cause of death				
	Natural	External	Pending	SIDS and other undetermined	Total deaths
<5	15.9	3.6	0.0	0.9	165
5–<10	21.2	5.2	0.4	1.6	1,101
10–<15	26.9	5.8	0.6	2.2	988
15+	29.1	7.0	0.9	4.7	319
NSW	**23.4**	**5.4**	**0.5**	**2.0**	**2,573**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Key findings—variation by area-level characteristics

The risk of dying during childhood is greater for children living in more disadvantaged areas; the pattern is consistent across all included indicators. The likelihood of dying during childhood is:

- 1.7 times as high for children in high poverty areas compared with those in low poverty areas
- 1.8 times as high for children in areas with the lowest levels of school engagement among 16-year-olds
- 1.5 times as high for children in areas with the highest levels of overcrowded housing
- 2.0 times as high for children in areas where 15% or more of children have been assessed as developmentally vulnerable on at least 2 of the 5 domains of the AEDC. This difference persists across all causes of death, where those in the areas of highest vulnerability are 1.8 times as likely to die of natural causes and 1.9 times as likely to die from external causes (such as transport-related accidents, accidental poisoning, drowning).

5 Suggestions for further research

This report presents an initial examination of the spatial distribution of child deaths across New South Wales and the area-level characteristics associated with that variation. It shows that there is considerable variability across areas, and that there are a number of area-level characteristics associated with increased risks of child death. The findings also highlight the importance of looking within areas at the detailed causes of death and characteristics of children who died.

Because of small numbers, detailed rates by specific causes of death could not be calculated reliably. The project would also have liked to focus more specifically on the risk of death for Indigenous children and for those with a child protection history, but it was hampered both by small number issues and accurate data on the at-risk population (that is, the numbers of Indigenous children and the number of children with a child protection history at the small area level). Future work could focus more specifically on these groups.

The analyses in this report are descriptive in nature and rely on aggregate mortality rates. Ideally, future analyses would be able to model the effect of individual- and area-level characteristics on the risk of child death, not just on the cause of death distribution among those children who have died. This would require linkage of CDRT's data with perinatal and births data to create a longitudinal data set (similar to the linked perinatal, births, deaths data set that AIHW has recently created).

Appendix A: Selection of geographic structure

The challenge for any spatial analysis is selecting a geographic structure or level that is large enough to support reliable rates but small enough to reflect local conditions, that has appropriate population data for calculating rates, that has data on other key area-level attributes, and that can support further aggregation or disaggregation.

Four potential classifications were considered:

- local health districts (LHDs)
- primary health networks (PHNs)
- local government areas (LGAs)
- the ABS ASGS structure.

Maps illustrating the boundaries of each of the first three classifications are presented in figures A1 (LHDs), A2 (PHNs) and A3 (LGAs).

Each of these four potential geographies has strengths and weaknesses. LGAs, LHDs and PHNs all have the advantage of being administrative boundaries, with various programs and policies attached. However, they also have inherent drawbacks:

- The number and boundaries of health districts (or health service areas) change over time. Currently, there are 8 LHDs in Sydney and 7 LHDs that cover regional and remote areas, the boundaries of which were established in 2011.
- PHNs are relatively new organisations (established 1 July 2015). Currently, there are 10 PHNs in New South Wales, some of which are quite large geographically.
- Local government boundaries change over time. As of February 2016, there were 80 LGAs, plus a large unincorporated area in north-western New South Wales.

Another issue faced by these geographies was a lack of available yearly population data to calculate rates, other key contextual information (such as SEIFA), and the inability to further aggregate or disaggregate rates.

For these reasons, the ABS ASGS structure, which is a series of SA levels that build on one another, and was developed for the purpose of outputting statistics (see Box A1, following the maps), was chosen as the most appropriate geographic structure for this project.

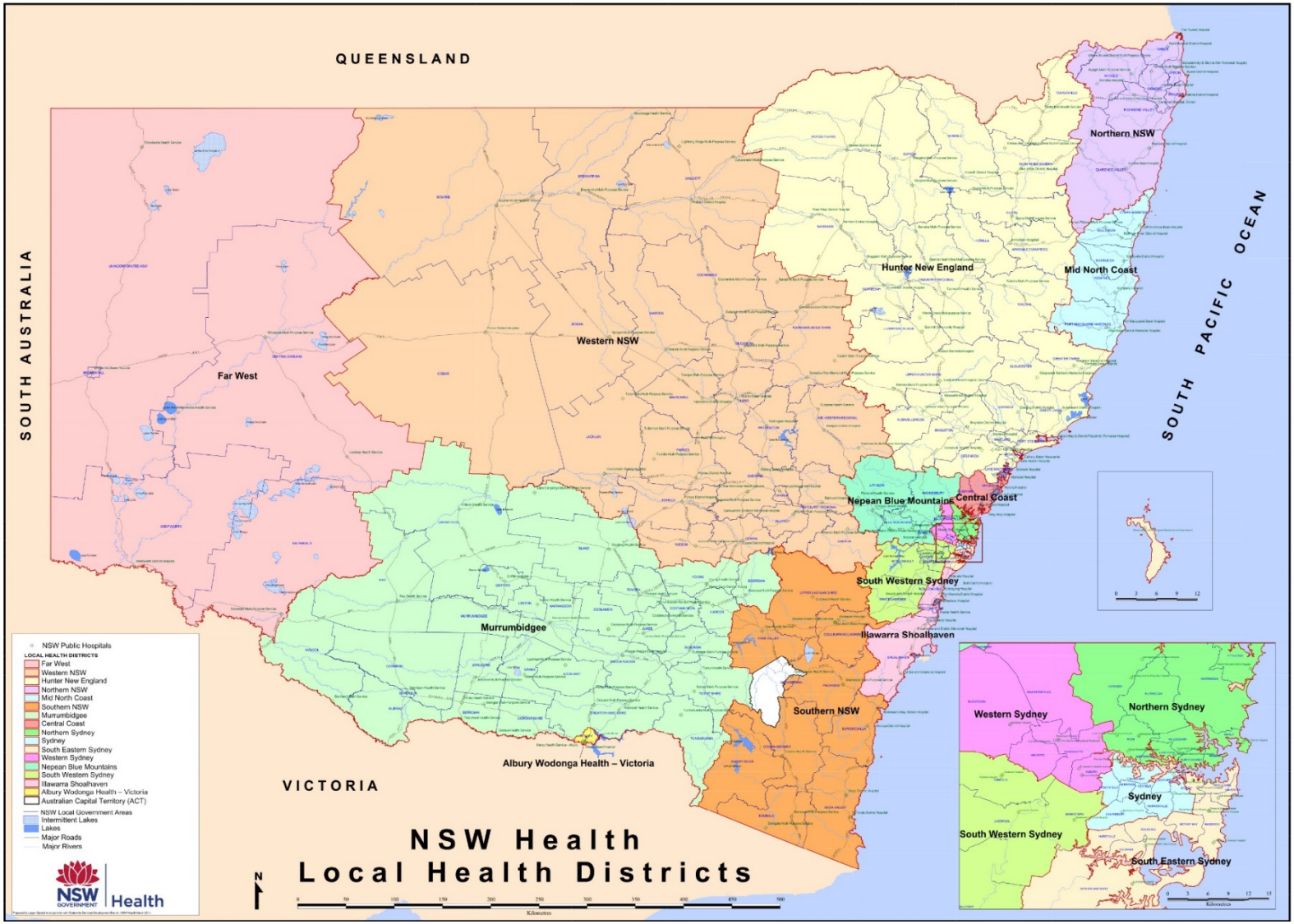


Figure A1: NSW Local Health Districts

Figure A2: NSW Primary Health Networks

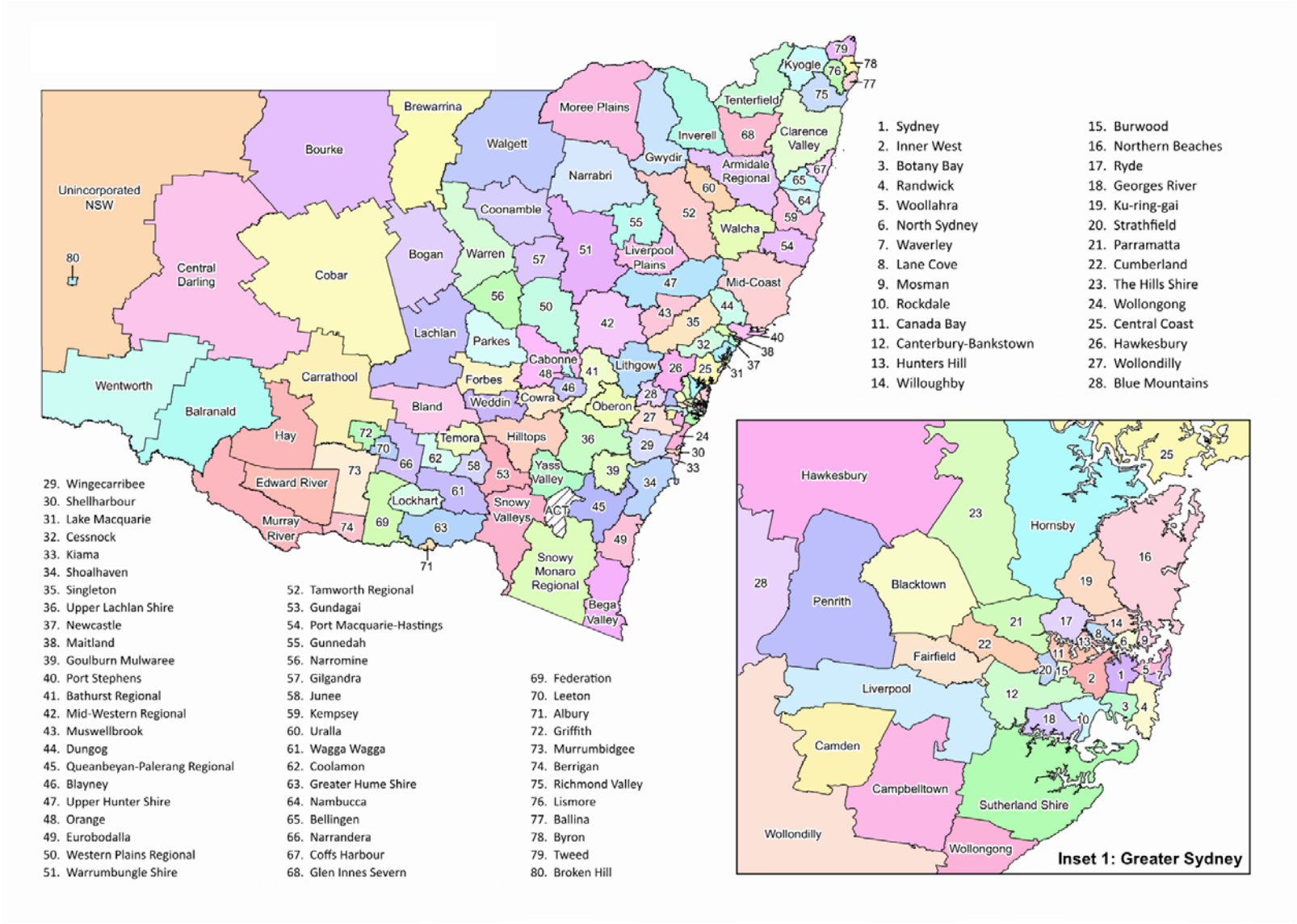
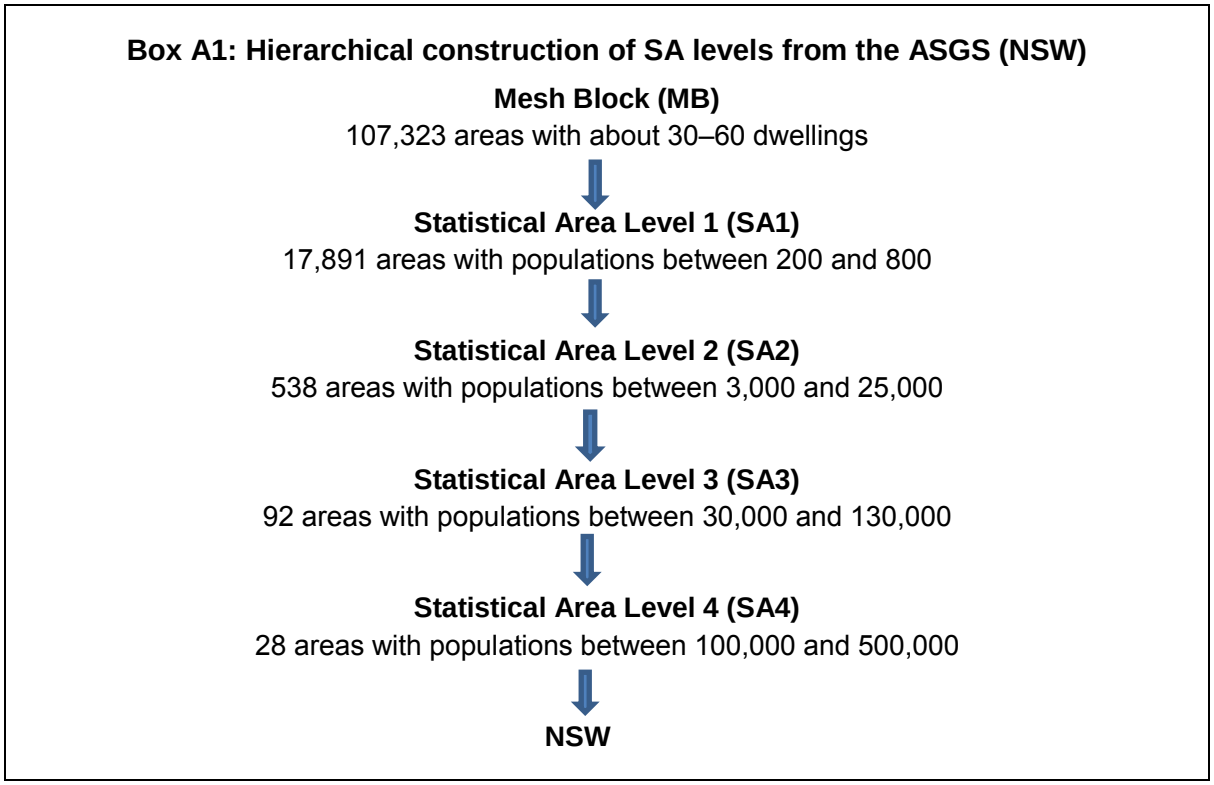


Figure A3: NSW local government areas, 2016

Box A1: Hierarchical construction of SA levels from the ASGS (NSW)



SA1, SA2, SA3 and SA4 level codes were assigned to each record, along with SA1 level remoteness categories. The ABS has published SA2 level population data for 5-year age groups from 2001 onwards, and has also provided the number of births at SA2 level from 2001–2014. However, the small number of deaths by SA2 means that death rates at this level will not be reliable. The population data were aggregated to SA3 level and used as the denominator for the SA3 level child death rates. Lower level geographic information was used where appropriate in the analyses (Table A1).

Table A1: Summary of geographic levels by type of analysis

Purpose/analysis	Geographic level
Tests for spatial patterns in the data	SA2
Spatial distribution of Infant and child mortality rates	SA3
Identification of areas with significant changes over time	SA3
Aggregated child deaths by area-level characteristics (such as remoteness, SEIFA)	SA2, SA3

Appendix B: Additional tables

Table B1: Percentage distribution of child deaths (ages 0–17), by characteristic and time period

		Period		
Characteristic	**Categories**	**2001–2005**	**2006–2010**	**2011–2015**
Cause of death	Assault	1.9	2.0	1.1
	Drowning	2.8	2.6	2.2
	Natural cause	80.2	81.1	75.9
	Other unintentional or external	3.7	3.5	3.1
	Pending	0.0	0.0	1.6
	Suicide	2.8	2.3	3.9
	Transport	8.3	7.1	5.7
	Undetermined /not applicable	0.3	1.6	6.6
Indigenous status	Indigenous	7.3	8.9	9.8
	Non-Indigenous	92.2	90.5	89.7
	Missing	0.5	0.6	0.0
Child protection history	Yes	15.4	22.8	20.2
	No	84.1	76.2	79.5
	Missing	0.4	1.0	0.0
Age (years)	Under 1	60.0	63.3	61.9
	1–4	13.1	11.5	11.1
	5–9	7.3	6.6	7.9
	10–14	7.6	7.3	7.0
	15–17	12.0	11.5	12.1
Remoteness	Major cities	69.5	71.5	71.5
	Inner regional	21.9	20.8	20.4
	Outer regional	7.5	7.0	7.2
	Remote	0.8	0.6	0.7
	Very remote	0.4	0.2	0.2
Child mortality rate (deaths per 100,000 children aged 0–17)		40.3	36.6	31.5
	Total deaths	**3,176**	**2,907**	**2,574**

Note: The table includes only those deaths occurring in NSW where the children's residential address was in NSW when they died and where the address could be geocoded.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Table B2: Percentage distribution of child deaths (ages 0–17), by Indigenous status, 2011–2015

Characteristic	Categories	Indigenous	Non-Indigenous
Cause of death	Assault	1.6	1.0
	Drowning	4.0	2.0
	Natural Cause	59.3	77.9
	Other unintentional or external	5.1	3.9
	Pending	4.3	1.2
	Suicide	4.3	3.8
	Transport	9.5	5.2
	SIDS and other undetermined /not applicable	11.9	6.0
Child protection history	Yes	53.8	16.3
	No	46.2	83.7
Age (years)	Under 1	66.8	61.6
	1–4	13.0	10.8
	5–9	5.1	8.2
	10–14	4.3	7.2
	15–17	10.7	12.3
Remoteness	Major cities	40.3	74.5
	Inner regional	35.2	18.9
	Outer regional	18.6	5.9
	Remote and very remote	5.9	0.3
	Total deaths	**253**	**2,308**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: NSW CDRT register of child deaths in NSW.

Table B3: Percentage distribution of child deaths (ages 0–17), by child protection history, 2011–2015

Characteristic	Categories	Child protection history	No child protection history
Cause of death	Assault	3.1	0.6
	Drowning	4.4	1.7
	Natural Cause	55.1	81.0
	Other unintentional or external	5.8	2.4
	Pending	3.5	1.1
	Suicide	7.5	2.9
	Transport	8.1	5.1
	SIDS and other undetermined /not applicable	12.5	5.1
Indigenous status	Indigenous	26.6	5.7
	Non-Indigenous	73.4	94.3
Age (years)	Under 1	50.9	64.7
	1–4	14.5	10.2
	5–9	8.1	7.9
	10–14	9.4	6.4
	15–17	17.1	10.9
Remoteness	Major cities	58.2	74.7
	Inner regional	30.5	18.0
	Outer regional	10.0	6.5
	Remote and very remote	1.5	0.7
	Total deaths	**519**	**2,047**

Note: The table includes only those deaths where the children's residential address was in NSW when they died and could be geocoded, and where the death occurred in NSW.

Source: AIHW analysis of the NSW CDRT register of child deaths in NSW.

Table B4: Area-level variables by domain, geographic level and data source

Domain	Variables	Geographic level
Economic context	SEIFA IRSD[(a)]	SA2
	Unemployment rate[(b)]	SA3
	Poverty rate (synthetic estimates) – proportion of people below a half median equivalised disposable household income poverty line[(c)]	SA2
	Percentage who would have difficulty accessing funds in an emergency (synthetic estimates)[(c)]	SA2
Social capital	Percentage of adults engaged in unpaid volunteer work[(b)]	SA3
	Percentage of 16-year-olds in full-time secondary school education[(b)]	SA3
	Percentage of those aged 20–54 who completed Year 12[(b)]	SA3
Housing	Percentage living in overcrowded housing (combines the ABS categories of 'other overcrowded' and 'severe overcrowding')[(d)]	SA3
	Rental stress, low income households (households in the bottom 40% of the income distribution (those with less than 80% of median equivalised income), spending more than 30% of their income on rent, as a proportion of rented private dwellings)[(e)]	SA2
	Percentage of rented housing that is rented from the government housing authority[(e)]	SA2
Child health and development	Percentage of children developmentally vulnerable in 2 or more of the 5 domains—average of 2009, 2012, 2015 values[(f)]	SA2

Data sources

(a) ABS 2033.0.55.001—Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2011.

(b) ABS Basic Community Profiles data packs, www.abs.gov.au (2011 Census of Population and Housing).

(c) Indicators are based on data from the Survey of Income and Housing and the Census of Population and Housing 2011, sourced from NATSEM SA2 OECD indicators: income, inequality and financial stress 2011, through the AURIN portal. Note that estimates were produced by NATSEM's Spatial Microsimulation model, which is described further in Tanton et al. (2011).

(d) ABS 2049.0—Census of Population and Housing: estimating homelessness, 2011.

(e) Indicators are based on data from the Census of Population and Housing 2011, calculated by Torrens University Australia—Public Health Information Development Unit, (2014): SA2 Housing Transport. Sourced from the AURIN portal.

(f) AEDC. Public table by Statistical Area Level 2 (SA2) 2009–2015 AEDC data by SA2 (2009, 2012, and 2015) <http://www.aedc.gov.au/resources/detail/public-table-by-statistical-area-level-2-(sa2)-2009-2015>.

Table B5a: Descriptive statistics, SA2-level contextual variables

		Poverty rate (%)	Difficulty accessing funds (%)	Engaged in school (%)	Rental stress (%)	Government housing (%)
Mean		11.2	14.4	76.6	25.6	3.8
Median		10.9	14.4	79.5	26.0	2.3
Standard deviation		4.3	4.9	17.3	9.8	4.6
Minimum		0.0	0.0	0.0	0.0	0.0
Maximum		29.6	37.6	100.0	49.4	33.1
Cut-off points for quartiles	25	7.8	11.0	73.6	19.4	0.6
	50	10.9	14.4	79.5	26.0	2.3
	75	13.9	17.4	85.1	32.5	5.3
SA2s with valid data		497	497	538	538	538
SA2s with missing data		41	41	0	0	0

Source: See Table B4 for sources and definitions.

Table B5b: Descriptive statistics, SA3-level contextual variables

		Unemployment rate (%)	Volunteering (%)	Year 12 attainment (%)	Overcrowding rate (per 10,000)
Mean		5.8	18.2	54.7	42.7
Median		5.5	19.1	50.5	25.5
Standard deviation		1.7	4.9	15.8	42.8
Minimum		2.8	7.3	29.6	0.0
Maximum		9.6	27.9	87.4	224.5
Cutoff points for quartiles	25	4.4	15.0	41.2	14.6
	50	5.5	19.1	50.5	25.5
	75	7.0	22.0	68.0	67.2
SA3s with valid data		88	88	88	72
SA3s with missing data		0	0	0	19

Source: See Table B4 for sources and definitions.

Table B6: Descriptive statistics, SA2 level AEDC (N = 539 SA2s)

Statistic	SA2 level percentage of children vulnerable across 2 or more domains of the AEDC
Mean	9.63
Median	9.20
Standard deviation	3.94
Minimum	1.19
Maximum	31.78

Source: AEDC. Public table by Statistical Area Level 2 (SA2) 2009–2015 AEDC data by SA2 (2009, 2012, and 2015) <http://www.aedc.gov.au/resources/detail/public-table-by-statistical-area-level-2-(sa2)-2009-2015>.

References

ABS (Australian Bureau of Statistics) 2015. Births, Australia, 2014. ABS cat. no. ABS 3301.0. Canberra: ABS.

ABS 2017. Population Estimates by Statistical Geography (ASGS 2011), 1991 to 2016.

AIHW (Australian Institute of Health and Welfare) 2014. Child social exclusion and health outcomes: a study of small areas across Australia. Bulletin no. 121. Cat. no. AUS 180. Canberra: AIHW.

AIHW 2016. Australia's health 2016. Australia's health series no. 15. Cat. no. AUS 199. Canberra: AIHW.

AIHW 2017. Aboriginal and Torres Strait Islander Health Performance Framework 2017: supplementary online tables. Cat. no. WEB 170. Canberra: AIHW.

Moore T, McDonald M & McHugh-Dillon H 2014. Early childhood development and the social determinants of health inequities: a review of the evidence. Parkville, Victoria: Centre for Community Child Health at the Murdoch Children's Research Institute and the Royal Children's Hospital.

NSW (New South Wales) Child Death Review Team 2014. Causes of death of children with a child protection history, 2002–2011. Sydney: NSW Ombudsman.

NSW Child Death Review Team 2015a. A scan of childhood injury and disease prevention infrastructure in NSW. Prepared by the Centre for Health Service Development, Australian Health Services Research Institute, University of Wollongong. Sydney: NSW Ombudsman.

NSW Child Death Review Team 2015b. Drowning deaths of children (private swimming pools) 2007–2014. Sydney: NSW Ombudsman.

NSW Child Death Review Team 2016a. Child Death Review Report 2015. Sydney: NSW Ombudsman.

NSW Child Death Review Team 2016b. Child deaths from vaccine preventable infectious diseases, NSW 2005–2014. Prepared by the National Centre for Immunisation Research and Surveillance. Sydney: NSW Ombudsman.

Ring IT, Dixon T, Lovett RW & Al-Yaman F. 2016. Are Indigenous mortality gaps closing: how to tell, and when? Medical Journal of Australia 205(1):11.

Saunders P 2012. Report for the NSW Child Death Review Team on measuring socioeconomic status. Sydney: Social Policy Research Centre.

List of tables

List of figures