Maternal incarceration, low birth weight, and infant mortality in a longitudinal sample of Western Australian children

by

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List of Abbreviations

ABS	Australian Bureau of Statistics
ACE	Adverse Childhood Experience
AIC	Akaike Information Criterion
AIHW	Australian Institute of Health and Welfare
ARIA	Accessibility/Remoteness Index of Australia
ASOC	Australian Standard Offence Classification
BBV	Blood Borne Virus
CD	Collection District
CI	Confidence Interval
CPFS	Child Protection and Family Support
DCS	Department of Corrective Services
DOHAD	Developmental Origins of Health and Disease
ED	Emergency Department
HMDC	Hospital Morbidity Data Collection
ICD	International Statistical Classification of Diseases
IQR	Interquartile Range
IRSD	Index of Relative Socio-Economic Disadvantage
LGA	Local Government Area
M	Mean
Mdn	Median
MHIS	Mental Health Information System
MNS	Midwives Notifications System
N	Number
NSW	New South Wales
OECD	Organisation for Economic Co-operation and Development
OR	Odds Ratio
PR	Prevalence Ratio
PTSD	Post-Traumatic Stress Disorder
ROC	Receiver Operating Characteristic
RR	Relative Risk
SD	Standard Deviation
SEIFA	Socio-Economic Indexes for Areas
SLA	Statistical Local Area
STI	Sexually Transmitted Infection
TBI	Traumatic Brain Injury
TOMS	Total Offender Management System
UK	United Kingdom
US	United States
VIF	Variance Inflation Factor
WA	Western Australia
WAAHEC	Western Australian Aboriginal Health Ethics Committee
WADLS	Western Australian Data Linkage System
WHO	World Health Organization

Summary

Prior to the work in this thesis it was known that women prisoners experience increased levels of adversity and disadvantage including domestic violence, mental illness, alcohol and substance-use disorders. It was also understood that these and similar risk factors in the family environment contribute to an increased risk of poor outcomes for children. Despite the potential vulnerability of children of women prisoners, however, there was little known about this population including the nature of their exposure to maternal imprisonment, and their health and welfare. Population statistics on children of prisoners have not been routinely collected in Australia and this has limited the extent to which the specific needs of this group have been able to be addressed in existing criminal justice policy and practice. In Australia, Aboriginal women represent the fastest growing sub-group within the prison population. It is known that Aboriginal infants in the general population, are at increased risk of poor outcomes in early life such as low birth weight and infant mortality.

Aim

The central aim of this thesis was to address the lack of empirical evidence available on children of women prisoners, and to establish early life outcomes, including low birth weight and infant mortality, for Aboriginal and non-Aboriginal children.

Methods

Using linked administrative data, children born in Western Australia between 1985 and 2011 were identified whose biological mother was imprisoned during their childhood from birth to age 18-years (n=9,352). A comparison group was obtained of children born in Western Australia whose biological mother had no record of imprisonment from birth to age 18-years. Data were also obtained on the second-generation children born to the female members of the cohort and comparison groups. This resulted in a longitudinal sample of 44,765 infants which was used to address the aims of this thesis. Separate regression analyses were performed to determine whether maternal imprisonment during pregnancy is a determinant of infant mortality or low birth weight for Aboriginal and non-Aboriginal children.

Key Results

Childhood prevalence of maternal imprisonment was significantly higher for Aboriginal children with 18.8% of Aboriginal children affected by the imprisonment of their mother compared to 0.7% of non-Aboriginal children.

For 30.2% Aboriginal infants and 26.8% non-Aboriginal infants who were exposed to maternal incarceration in infancy, their mother was also imprisoned during pregnancy. Half of the children with a history of imprisonment in pregnancy or infancy also came into contact with child protection services by their second birthday.

Infant mortality rates for singletons were highest for Aboriginal infants with mothers *imprisoned during pregnancy* (32.1 per 1000) (RR 2.84; 95%CI 1.87-4.31; p<.001). Infant mortality rates for singletons were highest for non-Aboriginal infants with infants whose mothers were *first imprisoned after birth* (14.2 per 1000) (RR 3.42; 95%CI 2.24-5.23; p<.001). After adjusting for significant pregnancy risk factors, maternal imprisonment during pregnancy was the second strongest determinant of infant mortality for Aboriginal children. After adjusting for other significant pregnancy risks, maternal imprisonment before or during pregnancy remained strong determinants of low birth weight.

The prediction model developed for Aboriginal infants whose mothers were imprisoned during pregnancy, had poor discrimination for predicting low birth weight.

Implications

This is the first census of children affected by maternal incarceration within Australia. The results confirm a large disparity between Aboriginal and non-Aboriginal children with respect to maternal imprisonment. This is the first study to carry out a comprehensive investigation of infant mortality outcomes for children of prisoners. It is also the largest study to date that has investigated low birth weight outcomes for infants of mothers imprisoned during pregnancy. While it was not possible to develop a predictive model with high discrimination for low birth weight in our study sample, strong individual factors related to maternal contact with the corrections system were identified. The work in this thesis highlights that there are particular sub-groups within the prisoner population who are at higher risk of poor perinatal outcomes, with specific implications for the development of criminal justice system policy.

Declaration

This thesis presents work carried out by myself and does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, are clearly acknowledged.

Caitlin Dowell 28 August 2018

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I formally acknowledge that material presented cannot be considered as either endorsed by the Western Australian Department of Justice or an expression of the policies or view of the Department, and any errors or omission or commission are the responsibility of myself i.e. ‘the Researcher’. Responsibility for interpretation of the data supplied through the Government of Western Australia, the Developmental Pathways in Western Australian Children Project, and by any other data custodian, is also the Researchers’ alone.

I was supported by an Australian Government Research Training Program Scholarship.

Thesis Containing Published Research Declaration

This thesis is submitted as a Thesis Containing Published Research in accordance with UniSA Academic Regulations for Higher Degrees by Research, Clause 16.1.1b. I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes three original papers published in peer reviewed journals and one unpublished publication. The core theme of the thesis is the health and welfare of children of women prisoners. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the School of Health Sciences under the supervision of Professor Leonie Segal, Professor David Preen, and Doctor Gloria Mejia.

My contribution to published work is outlined below:

Thesis Chapter	*Publication Title*	*Status*	*Nature and % of student contribution*	*Co-author name(s) Nature and % of Co-author's contribution*
Chapter 5 Appendix I	Quantifying maternal incarceration: a whole-population linked data study of Western Australian children born 1985-2011	Published	80%. Primary responsibility of the study design, conduct of the data analysis and interpretation, and drafting the initial and final versions of the manuscript.	Leonie Segal – 10% David Preen – 10% Contributed to the study design, interpretation of findings and drafts of the manuscripts.
Chapter 6 Appendix I	Maternal incarceration, child protection, and infant mortality: a descriptive study of infant children of women prisoners in Western Australia	Published	75%. Primary responsibility of the study design, conduct of the data analysis and interpretation, and drafting the initial and final versions of the manuscript.	Leonie Segal – 10% David Preen – 5% Gloria Mejia – 10% All contributed to the study design, interpretation of findings and drafts of the manuscripts. Gloria Mejia contributed to the data analysis.
Chapter 7 Appendix I	Determinants of infant mortality for children of women prisoners: a longitudinal linked data study	Published	75% Primary responsibility of the study design, conduct of the data analysis and interpretation, and drafting the initial and final versions of the manuscript.	Leonie Segal – 10% David Preen – 5% Gloria Mejia – 10% All contributed to the study design, interpretation of findings and drafts of the manuscripts. Gloria Mejia contributed to the data analysis.
Chapter 8	Low birth weight and maternal incarceration in pregnancy: a longitudinal linked data study of Western Australian infants	Under review	75%. Primary responsibility of the study design, conduct of the data analysis and interpretation, and drafting the initial and final versions of the manuscript.	Leonie Segal – 10% David Preen – 5% Gloria Mejia – 10% All contributed to the study design, interpretation of findings and drafts of the manuscripts. Gloria Mejia contributed to the data analysis.

Caitlin McMillen Dowell
25 August 2018

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work.

Prof Leonie Segal 28 August 2018

Prof David Preen Date 26/08/2018

Dr Gloria Mejia 28 August 2018

1 Introduction

1.1 Rationale

Women prisoners are a highly vulnerable and disadvantaged population. Although the female prisoner population is smaller than the male population, the number of female prisoners is growing at a faster rate than male prisoners.[1] There are a number of differences in the characteristics of female and male prisoners including their offending profiles and level of socioeconomic disadvantage including low education, employment and homelessness.[2, 3] Women prisoners experience extremely high levels of physical, sexual and emotional abuse in childhood and as adults.[3, 4] It is therefore unsurprising that they also experience extremely high levels of mental illness, including alcohol and substance use disorders.[5, 6]

Aboriginal women prisoners are the fastest growing prison population in Australia.[7] This is not necessarily a result of an equivalent increase in offending behaviour but may be contributed to by discriminatory criminal justice system policies and practices particularly with respect to remand and sentencing, as has been demonstrated in New South Wales.[8] This is one example of the continuation of institutionalised discriminatory attitudes and practices that have impacted Aboriginal people since colonisation. Australia has a long-history of discrimination against Aboriginal people including land dispossession, forced removal of children from families, and exclusion of Aboriginal people from self-determination.[9] It is in this context that Aboriginal people experience the highest rates of imprisonment and poorer health outcomes. Aboriginal women and children, in particular, face disproportionately high levels of disadvantage in Australia and experience worse health outcomes than non-Aboriginal people.[9]

The Australian prisoner census is a point prevalence measurement of all prisoners held in Australian prisons on 30 June each year.[10] While this provides some information

about annual changes in the women's prison population, it does not provide a measure of how many women in total are imprisoned each year. For example, women are more likely to be imprisoned for shorter periods and more frequently than male prisoners,[2] which has implications for the total number of women in the prison population across a full year. Importantly the prisoner census does not include data on the parental status of prisoners.

Given the vulnerability of women prisoners is well documented, it is surprising how little empirical evidence or data are available on the children of prisoners. Some data derived from surveys or the Australian prisoner census exist,[4, 11, 12] but there are no routinely collected population-level statistics available on the extent of the population or characteristics of children affected by maternal imprisonment. This thesis will therefore provide baseline population data available on children of women prisoners in Australia. This information is critical for service planning, and to enable those providing support services to advocate for targeted support for specific service needs.

Existing literature on the children of prisoners has focussed mainly on the attachment between young children and infants with their children, and behavioural, delinquency, and educational outcomes for adolescent children.[13] There are also more studies published on outcomes for children affected by paternal or parental imprisonment, than for the children of women prisoners.[13] In general studies have largely focussed on whether parental imprisonment has an effect on child outcomes, over-and-above the effect of pre-existing disadvantage in the family environment. While there is some evidence that parental imprisonment does not have a separate, or measurable, effect beyond existing disadvantage,[14] conclusions have differed between studies in criminal justice jurisdictions across different countries.[13]

An alternative approach as expounded in the Adverse Childhood Experiences (ACE) literature is to understand the cumulative impact of exposure to adversity, including parental incarceration.[15] This approach considers that it is not soley the effect of maternal incarceration in isolation, but the combination of exposure to a range of factors that lead to the most risk for children.

Exposure to one set of adverse experiences can result in a 'snowball' effect of exposure to a growing number of other adverse experiences including incarceration.[16] In this context, parental incarceration likely represents the outcome of a number of prior

experiences of adversity and disadvantage occurring sometimes within a short period of time and a key period of risk for children. A key period of particular importance is early life given the vulnerability of the fetus and infant to a suboptimal intrauterine and postnatal environment, as highlighted in the literature within the Developmental Origins of Health and Disease field.[17-19]

Two of the most important health outcomes of exposure to maternal adversity within this period are infant mortality and low birth weight. Hence, the work in this thesis also uses a life course perspective, in addition to the ACE framework.

Infant mortality is the most significant indicator of the health and welfare status of a population,[20] but to our knowledge, there have been no studies which have investigated infant mortality outcomes for children of imprisoned mothers.[21]

Low birth weight also represents the outcome of a suboptimal intrauterine environment.[22] Furthermore, a birth weight of less than 2500g is associated with an increased risk of infant mortality, and of developing health problems in later life including poor cardiovascular and metabolic health.[23-29]

This thesis will address key gaps in the literature by assessing the strength of the relationship between maternal imprisonment and low birth weight compared to other pregnancy risk factors and investigate the prisoner characteristics of mothers who are at highest risk of low birth weight.

1.2 Research aims

The central aim of this thesis was to address the lack of empirical evidence available on children of women prisoners, and to establish early life outcomes, including low birth weight and infant mortality, for Aboriginal and non-Aboriginal children. The specific research aims for this thesis are:

1 To determine the prevalence and characteristics of exposure of children to maternal imprisonment in Western Australia.
2 To compare rates of infant mortality, low birth weight, and child protection system contact between the children of women prisoners and children in the general community.

3 To establish whether maternal imprisonment during pregnancy is a determinant of infant mortality.
4 To establish whether maternal imprisonment during pregnancy is a determinant of low birth weight.
5 To identify predictors, in particular, maternal incarceration factors, of low birth weight and infant mortality for infants of pregnant prisoners using routinely-collected administrative corrections data.

1.3 Research significance

This study provides the first census of children affected by maternal incarceration in Australia and explores the impact of changing practices in the corrections system on this population across time. Our research found that legislative changes made in 1994 to limit the use of imprisonment for default of fine resulted in fewer children being affected by maternal incarceration.[30] This is an example of the importance of population surveillance, to monitor the impact of changes in the criminal justice system for children of prisoners and highlights the importance of consideration of children of prisoners within legal and sentencing frameworks.

To date there have been few studies which have investigated whether the length of parental imprisonment operates through a dose-response relationship with respect to the risk of poor childhood outcomes.[31] There is evidence that longer prison stays have been found to be protective in relation to the perinatal outcomes of pregnant women, theoretically as a result of reduced maternal exposure to risk in the community.[32] There has, however, been little consideration of the impact of short-term imprisonment of pregnant women prisoners on their children. This subgroup within the prisoner population is difficult to recruit in prospective research designs, but in using linked administrative data, I have been able to include exposure to short-term imprisonment within the study population, filling an important gap in the literature.

We have, for the first time, demonstrated the high level of very short-term imprisonment of mothers (in Studies I and II reported in this thesis), and the number of children affected by maternal imprisonment for default of fine in Western Australia. This raises questions of the utility, and ethics, of such imprisonments, and the need to identify vulnerable families through the justice system to ensure the provision of family support services.

In this thesis I have quantified the differences between two measures of health and social wellbeing in populations of children with respect to their contact with the child protection system. The thesis presents the first comprehensive investigation of infant mortality and its' determinants for the children of women prisoners. The participant numbers allowed this comparison given the scale of the study required to investigate infant mortality which represents a rare outcome of pregnancy. This feature was strength of the methodology using linked administrative data in this thesis.

I have reported the first evidence that maternal imprisonment during pregnancy is an important risk factor for infant mortality for Aboriginal children. This is of significant importance and has implications for criminal justice policy, given the increasing rate of imprisonment of Aboriginal women.

This thesis also presents the largest investigation of low birth weight outcomes for children of women prisoners and an investigation for the first time of low birth weight outcomes for Aboriginal children compared to non-Aboriginal children of women prisoners.

The work in this thesis provides evidence that maternal imprisonment before and during pregnancy are determinants of low birth weight for Aboriginal and non-Aboriginal children of women prisoners. The relationship between maternal imprisonment during pregnancy and low birth weight outcomes was not as strong, however, as that found for infant mortality. This highlights the likelihood that different mechanisms may contribute to infant mortality compared to low birth weight outcomes for the children of women prisoners.

I also quantified, for the first time, the prevalence of other important pregnancy risk factors for infant mortality and low birth weight for infants by their maternal corrections history. Aboriginal and non-Aboriginal infants whose mothers were imprisoned before or during pregnancy experienced the highest rates of exposures in pregnancy to a range of risk factors related to maternal adversity. These include alcohol and substance use, related service contacts, hospitalisation for externally caused injury, and mental health issues, and having a sibling in contact with the child protection system during pregnancy. We found that the rates of maternal exposures to these factors in pregnancy were significantly higher than for infants with mothers who were first imprisoned after birth or who had a history of community corrections orders without imprisonment.

This thesis challenges the underlying assumptions that relatively short-term periods of imprisonment does not carry risk for children for women prisoners. This supports a different approach within the corrections system is required for the management of pregnant compared to non-pregnant Aboriginal and non-Aboriginal prisoners.

1.4 Thesis structure

This thesis contains ten core chapters. The rationale for the research, research aims and significance of the findings are outlined in Chapter 1 (Introduction) and the background and review of the literature relevant to the research aims is presented in Chapter 2.

The conceptual model of infant mortality and low birth weight, which was used to guide the research studies, is described in Chapter 3 and the project methodology is detailed in Chapter 4.

The first three research studies in Chapters 5-7 have been peer-reviewed and are presented as published within their respective academic journals. The fourth research study is currently under review for publication and is presented in Chapter 8. The final research study, in Chapter 9, is presented in chapter form.

The overall discussion of the key research findings and implications, the project limitations, and priority areas for future research are provided in Chapter 10 (Discussion).

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2 Background and Literature Review

2.1 Introduction

There are many issues which are relevant to research on the impact of maternal incarceration on the children of incarcerated mothers in Australia, including the unique history of Aboriginal and Torres Strait Islander people. Women in prison face a complex set of circumstances that are related to their offending history and the wellbeing of their children. These circumstances include histories of abuse, mental health and substance use disorders, and socioeconomic disadvantage. The literature has focussed on the potential outcomes of parental imprisonment on children from a number of perspectives. The aim of this chapter is to provide a review of the literature which provides the background for the aims of the studies which are reported in this thesis.

The first section of the literature review provides a brief description of the treatment of Aboriginal and Torres Strait Islander people in Australia since colonisation. This context provides an important background for the discussion in later sections of the thesis on the different factors which contribute to maternal incarceration and outcomes for Aboriginal and non-Aboriginal children.

The second section provides a summary of the Developmental Origins of Health and Disease framework as this provides the theoretical basis for interpreting the findings of the literature reviewed in the remaining sections of this thesis. It also informs the aims of the studies in this thesis.

The third section provides an overview of the characteristics and issues affecting incarcerated women and mothers, including their experiences of trauma, socioeconomic circumstances, incarceration and offending profile.

The fourth section provides a summary of the evidence on the prevalence and characteristics of children of incarcerated mothers in Australia.

The final section is an overview of the approaches to investigating the outcomes of children affected by parental incarceration, and reviews the existing literature on the infant mortality and low birth weight outcomes for infants whose mothers are imprisoned during pregnancy.

2.2 Aboriginal and Torres Strait Islander people in Australia

Aboriginal and Torres Strait Islander people are the Traditional Custodians of the lands of Australia. In 2011 there were an estimated 669,881 Aboriginal and Torres Strait Islander people living in Australia, representing 3% of the total Australian population.[1] The studies contained within this thesis relate to the population within the State of Western Australia. Western Australia is the largest Australian state or territory in terms of land size and fourth-largest in population at 2.4-million people. Western Australia is home to 13% of Australia's Aboriginal and Torres Strait Islander population.[1]

Aboriginal and Torres Strait Islander people are two distinct cultural groups with their own language groups and cultural practices. Within Western Australia, 96.3% of the Aboriginal and Torres Strait Islander population identify as Aboriginal, 1.8% as Aboriginal and Torres Strait Islander, and 1.9% as Torres Strait Islander. Throughout this thesis I use the term 'Aboriginal' as being inclusive of Aboriginal and Torres Strait Islander people,[2, 3] and in doing so mean no disrespect to the Torres Strait Islander population. I use the term 'Indigenous' in reference to the global context of Indigenous populations within countries other than Australia.

In 2011 Western Australia had the third largest population of Aboriginal people (88,270), after New South Wales (208,476) and Queensland (188,954), and the fourth largest proportion of Aboriginal people living within the eight Australian State or territory at 3.8% of the total Western Australian population, compared to 29.8% in the Northern Territory, 4.7% in Tasmania and 4.2% in Queensland.[1]

Just over one-third (37%) of Aboriginal people in Western Australia in 2011 lived in metropolitan areas of the State's capital city, Perth.[4] Close to one-quarter of Aboriginal people lived in regional areas, and 40% lived in remote and very remote areas of the State.[4] Across the State there are 274 remote Aboriginal communities.[5] Connection to country, culture and kin is important for Aboriginal people and particularly for the social and emotional wellbeing of remote Aboriginal communities.[5] The significance of

place and country means more than a geographical location, it encompasses cultural values, resources, obligations, practices, and ancestral connections.[2]

Since colonisation, Aboriginal people have suffered the devasting effects of British settlement including land dispossession, conflicts and massacres, the introduction of disease, assimilation policies, social and political exclusion, disenfranchisement, denial and disruption of culture, and the forced removal of children from their families.[4, 6] It has been estimated that between one-in-three and one-in-ten Aboriginal children were forcibly removed from their families between 1910 and 1970. These children comprise what are now known as the 'stolen generations'.[7] Systemic racism within government institutions continues to impact on Aboriginal people in their interaction with services.[8, 9] It is in this context that the disparities between health and social outcomes for Aboriginal and non-Aboriginal people exist and are maintained.

The importance of the history of discrimination against Aboriginal people is significant and requires consideration in any discussion of the criminal justice sector.[6, 8, 10] Aboriginal women are the fastest growing population in the Australian prison system, with a 26% increase in the rate of imprisonment of Aboriginal women between 2011 and 2014.[11] It is important to note that the while rates of Aboriginal imprisonment are significant, the majority of Aboriginal people have never been imprisoned or charged with committing an offence.[6]

It is important to note that the increase in the rate of imprisonment of Aboriginal women is not necessarily a result of an equivalent increase in the rate of offending. Research in New South Wales attributed one-quarter of the rise in Aboriginal imprisonment in that State between 2001 and 2008 to an increase in the number of remandees, which appeared to be due to an increase in refusal of bail and of time spent in remand.[12] Refusal of bail can be driven by socioeconomic factors, as bail is often contingent on having stable accommodation, which can result in offenders being detained on remand in instances where they would otherwise be released before trial.[13] Three-quarters of the increase in Aboriginal imprisonment in New South Wales was attributed to an increase in the number of sentenced prisoners, and specifically because more Aboriginal offenders received prison sentences rather than alternative sentencing options such as community-based corrections orders, and was also attributed to an increase in sentence length.[12] The investigation found there was not an increase in the number of Aboriginal

people brought before the court between 2001 and 2008, and overall there was a decrease in the number of Aboriginal defendants found guilty.[12]

Aboriginal women also have high rates of victimisation in crime.[14] In Western Australia in 2001, Aboriginal women were 12 times more likely than non-Aboriginal women to be victims of assault.[14] For Aboriginal mothers incarcerated in Western Australia, a complex relationship exists between victimisation and perpetration of violence.[15] Interviews with 84 Aboriginal mothers incarcerated in Western Australia in 2013, found 90% of women had experienced violence and 64% of women had used violence against others.[15] Mothers within the study described using violence largely as a way to manage their own victimization.[15] The study also highlighted the impact of Aboriginal mothers' distrust of the criminal justice system, with mothers describing instances of family violence where they did not contact police because they feared their child would be removed from their care by child protection services.[15]

The overrepresentation of Aboriginal children in care is a significant issue in Australia given the prior and continuing impact of the history of the stolen generations on Aboriginal families. In this context, the imprisonment of Aboriginal mothers is a particularly important issue given the family disruption which may contribute to an intergenerational cycle of disadvantage.

The studies reported in this thesis investigate whether there are differences between the characteristics of Aboriginal and non-Aboriginal women prisoners and the outcomes of their children.

2.3 The Developmental Origins of Health and Disease

In any investigation of the women prisoner population it is important to understand the factors in a woman's life that have contributed to her contact with the criminal justice system. It is also the case that experiences of adversity within a mother's own life have long lasting impacts on her children's development and their later health.

A framework for the Developmental Origins of Health and Disease (DOHAD) has been developed over the past 30 years which has been used in this thesis as a guide to understand the nature and significance of exposures to adversity for women prisoners and their children.

The DOHAD framework stemmed from early epidemiological research by Barker and colleagues.[16-18] These authors carried out epidemiological investigations within local areas of England and Wales on the distribution of rates of infant mortality and low birth weight in the 1920s and ischaemic heart disease in the 1970s. They reported that there was a relationship between infant mortality rates and adult heart disease some 50 years later within the geographic regions. Barker provided the explanation as a hypothesis that this relationship *"reflects variations in nutrition in early life, which are expressed pathologically on exposure to later dietary influences"*.[17] This hypothesis was later described as the 'fetal origins of adult disease' hypothesis and a range of subsequent studies have explored and honed this hypothesis and provided further evidence on mechanisms which may underly the relationship between fetal and adult health outcomes. Subsequently the hypothesis has been reframed as the developmental origins of adult health and disease to reflect the *"broader scope of developmental cues, … and the concept that the early life environment has widespread consequences for later health"*.[19] The body of evidence supporting the DOHAD framework is robust, spanning different countries, populations, as well as from different study designs including human observational studies and experimental animal models.[20]

A significant body of work has demonstrated how a range of biological, psychological and social factors impact on the fetus during pregnancy, and the child during infancy and early life to increase the risk of poor health in later life.[20-22] Exposure of the mother or fetus during pregnancy or of the individual after birth to factors such as poor nutrition, alcohol and drugs, infections, domestic violence, and stress can result in poor health outcomes including low birth weight and infant mortality and the emergence of ischaemic heart disease, diabetes and obesity in adulthood.[16, 20, 23] Exposure to factors associated with adversity impact on development through mechanisms such as epigenetic programming, resulting in modifications to the structure of DNA (without altering the nucleotide sequence) which can result in changes in gene expression.[24, 25]

Two broad mechanisms have been proposed for the developmental origins of poor health; the early programming and cumulative pathways models as defined in Wadhwa et al (2011). The early programming model is summarised as *"a stimulus or insult (e.g. stress), operating at a critical or sensitive period, can result in a permanent or long-term change in the structure or function of the organism that becomes manifest in health and disease risk in later life"*.[26] The cumulative pathways model suggests *"that*

throughout the life-course exposures and insults gradually accumulate through episodes of illness or injury, adverse environmental conditions and risky behaviors, leading to declines in health and function over time".[26]

There is evidence that exposure of the mother to adversity throughout her own lifecourse, particularly exposure to psychosocial stressors just prior to conception of her infant, can impact the development of her infant.[27]

Evidence from studies of women prisoners highlight that this population can experience adversity and trauma throughout their life-course. In this context the DOHAD Framework provides a way of understanding the relevance of exposure to adversity for women prisoners and their children during key developmental periods and the importance of cumulative trauma. This thesis focuses on the characteristics of women prisoners in the context that the child outcomes of incarcerated mothers may represent the impact of the cumulative exposure of these prisoners to adversity.

2.4 Characteristics of incarcerated women and mothers

Globally, the rate of incarceration of women is lower than for men. In Australia the rate of male imprisonment on 30 June 2017 was 12 times that of women's, at 404.3 per 100,000 men compared to 34.0 per 100,000 women.[28] Although fewer women are imprisoned than men, the female prison population has been growing at a faster rate compared to the male population. In Australia between 30 June 2007 and 30 June 2017 the rate of imprisonment increased by 38.8% for women compared to 25.4% for men.[28]

In Australia, the highest rate of female imprisonment is in the Northern Territory at a rate of 125.3 women per 100,000 population, followed by Western Australia at 68.6 per 100,000, taken on 30 June 2017.[28] Aboriginal women are disproportionately affected, with rates of imprisonment as high as 998.6 per 100,000 in Western Australia, 537.9 per 100,000 in the Australian Capital Territory, 473.5 per 100,0000 in New South Wales, and 463.1 per 100,000 in South Australia, in 2017.[29]

Women prisoners have complex histories which relate to both their offending as well as their children's health, development, and wellbeing. The range of issues include women's own childhood histories of abuse and neglect, their experience of family violence, poor mental health, alcohol and other substance use, low education, unemployment and welfare dependency, homelessness and housing instability. These

key issues are described below for women prisoners in general and, where the data allows, for mothers specifically.

In this thesis information relating specifically to women in the Western Australian context is also presented where possible. The description below draws largely on a 2008 survey of Western Australian women prisoners conducted by the Department of Corrective Services, which included 64 women (32 Aboriginal, 32 non-Aboriginal) detained in Western Australian prisoners between March and August 2008, representing approximately one-quarter of the total female prison population in Western Australia over that period.[30] I also frequently draw from the results of a survey of the mental health and substance use problems of Western Australian prisoners who were received in prison between June 2012 and September 2013.[31] The 2012-2013 survey included 145 women and 574 men, achieving an overall response rate of 16.[31]

2.4.1 Histories of trauma

Aboriginal and non-Aboriginal female prisoners experience extremely high rates of trauma as children and adults, with 90% of Western Australian women prisoners in 2008 reporting being abused at some point during their lives.[30] For Aboriginal women, 94% reported having experienced abuse, with 59% of those reporting abuse experiencing it in childhood and 97% in adulthood.[30] For non-Aboriginal women, 86% reported abuse, and of those women 40% were abused as children and 88% as adults.[30]

Similar proportions of Aboriginal and non-Aboriginal women were affected by abuse in the 12 months preceding imprisonment.[31] In 2012-2013, 44% of Western Australian women prisoners reported experiencing 'abuse or violent crime' and 38% reported being 'abused, raped or beaten up' in the 12 months prior to imprisonment.[31]

There is a strong link between a history of abuse and the development of mental health issues such as post-traumatic stress disorder (PTSD), psychosis, depression, anxiety, and substance abuse disorders.[32]

Outside of the prison population, there is evidence that traumatic brain injuries (TBI) acquired through family violence impact on victims' cognitive function and increase the risk of mental illness.[33] It has also been postulated that it is not only physical damage to the brain sustained through a TBI that impacts on victims of family violence, but that cell death in specific areas of the brain may be related to the repeated overstimulation of

the stress response experienced as a consequence of family violence or child maltreatment.[34] Furthermore, more severe symptomology is experienced by sufferers of mild TBIs who also have a history of sexual abuse.[35]

There is also evidence of an association between a history of TBI and an increased risk of offending, theoretically due to a reduction in impulse control caused by brain injury.[36, 37] Differences have consistently been shown between inmates who are incarcerated for violent and non-violent offences, with violent offenders more likely to have a history of sustaining head injuries with discrete neurological damage. This is true even when previous academic problems or school delinquency are taken into account.[38]

It is difficult to ascertain the incidence of TBIs in victims of family violence due to an underreporting of cases.[39, 40] Similar proportions of Aboriginal and non-Aboriginal women prisoners in 2012-2013 reported a history of head or neck injuries requiring treatment in hospital (44% Aboriginal and 38% non-Aboriginal women), acquired in a vehicle accident (18% Aboriginal and 23% non-Aboriginal women), or acquired in a 'fight, assault, accident, etc' (51% Aboriginal and 45% non-Aboriginal women).[31] Overall, 35% of Aboriginal women and 42% of non-Aboriginal women reported being knocked unconscious.[31]

In summary, women prisoners experience high rates of physical, sexual and emotional trauma throughout their lifecourse. There is evidence of a link between trauma, particularly in acquired TBIs, and offending. Importantly, the DOHAD literature has demonstrated how severe and repeated experiences of trauma have potential impacts for mothers' own long-term health and the health and development of their children.

2.4.2 Health of women prisoners

Women prisoners experience higher rates of a range of health conditions, some of which impact directly or indirectly on their children's health and wellbeing. The areas that are most important to discuss in the context of this thesis are mental health, alcohol and other substance disorders, blood borne viruses and sexually transmitted infections, and fertility, as these factors have implications for women and for the health and development of their children.

Mental health

Considering the high rates of abuse and neglect and TBI experienced by the prison population, it is not surprising that incarcerated women also experience high rates of mental health disorders.[41]

An Australian study into community mental health service use of male and female prisoners in the year immediately prior to their imprisonment reported the service use was eight times higher when compared to non-offenders.[42] Non-Aboriginal women offenders were most likely to have used a mental health service in the year before imprisonment.[42] Prior mental health service use before imprisonment was found to predict death within two years post-release, with more than half the reported deaths attributed to injury or poisoning and pre-sentence mental health service use doubling the risk of death by these causes.[43]

In 2012-2013, a formal assessment of women prisoners' mental health found that nearly two thirds of Western Australian women prisoners (63%) met the criteria for a current diagnosis of mood disorders, anxiety disorders, PTSD or eating disorders, and one-fifth (20%) met the criteria for a psychotic disorder.[31] Prevalence of specific disorders relative to national averages for women in Australia, are shown in Table 2.1.[31] Only 13% of women prisoners had neither a mental health or substance use disorder.[31]

Table 2.1 Comparison of mental and related disorders experienced by Western Australian women prisoners and national averages (women aged 16-85 years)

Condition	Women prisoners (%)	National average (%)
Anxiety disorders	53	18
Mood disorders	36	7
Substance use disorders	74	3
Suicidal ideation in past month	27	3
Schizophrenia and related disorders	20	<1
Tobacco use in past 12 months	86	11
Cannabis use in past 12 months	64	8
Amphetamine/methamphetamine use in past 12 months	62	1.5

Note. Table data reproduced from Davison et al[31]

Generally, in the 2012-2013 assessment of Western Australian prisoners' mental health, Aboriginal and non-Aboriginal women were found to experience similarly high rates of

mental disorders, however, Aboriginal women were less likely to have accessed mental health services.[31]

Within the United Kingdom it has been found that 90% of imprisoned mothers with a child younger than 18-months, had a mental disorder (including substance use disorders) and 42% were depressed.[44] It has also been found in the United States that mental health issues are more common among female prisoners than male prisoners.[45-47]

A mother's mental health has significance for their child's development. High levels of depressive symptoms in mothers have been linked with poor attachment representations in their children.[48]

Alcohol and other substance use

In 2012-2013, 53% of Western Australian women prisoners had a co-occurrence of a mental illness with a substance use disorder.[31] Problems with alcohol and drug use are commonly associated with a history of abuse, either in childhood or as an adult.[41, 49]

The majority of Western Australian women prisoners (78%) reported problems with alcohol or other drug use in 2008.[30] Aboriginal women were more likely to report problems with alcohol than non-Aboriginal women (69% vs. 16%), whereas non-Aboriginal women were most likely to report problems with amphetamine use at 50%, compared to 38% of Aboriginal women.[30] In 2008, the majority of Western Australian women prisoners were smokers including 78% of Aboriginal women and 91% of non-Aboriginal women.[30]

Western Australian women prisoners were assessed against diagnostic criteria for substance use disorders in 2012-2013.[31] As shown in Table 2.2, Aboriginal women were more likely than non-Aboriginal women to meet the criteria for both alcohol and drug dependencies.[31]

As shown in Table 2.3, amphetamines and methamphetamines are the class of drugs most commonly used by Western Australian women prisoners in the 12 months preceding their imprisonment.[31] More women prisoners (63%) than male prisoners (51%) reported having ever injected amphetamine or methamphetamine.[31]

Table 2.2 Comparison of substance use disorders experienced by Western Australian women prisoners, by Aboriginal status, 2012-2013

Condition	Aboriginal women (%)	Non-Aboriginal women (%)
Alcohol dependence	39.6	17.9
Alcohol abuse	5.7	7.7
Drug dependence	69.8	51.3
Drug abuse	3.9	13.5
Any substance dependence or abuse	69.8	64.8

Note. Table data reproduced from Davison et al,[31] whether respondents fulfilled the diagnostic criteria for each disorder.

The majority of Western Australian women prisoners reported in 2008 that their offending was related to substance use (81%).[30] This was mainly due to being under the influence at the time of offending (71%), and less commonly to obtain (43%) or sell (21%) drugs.[30] Women reported that substance use disinhibited their behaviour and led to offending, particularly with respect to violent crimes.[30]

Table 2.3 Drug use within the 12 months prior to imprisonment for Western Australian women prisoners, 2012-2013

Substance	%
Amphetamines/methamphetamines	62
Benzodiazepines	19
Ecstasy	17
Cocaine	17
Hallucinogens	15
Heroin	15
Other opiates	12
Inhalants	3

Note. Table data reproduced from Davison et al[31]

Blood borne viruses and sexually transmitted infections

A high prevalence of blood borne viruses (BBVs) related to injecting drug use, in particular Hepatitis C, have been reported within the Australian prison population.[50-53]

National Prison Entrants' Bloodborne Virus Surveys were conducted every three years at multiple prison sites across Australia.[54] They included a consecutive cross-sectional sample of prison entrants over a two-week period at each prison site and include a questionnaire, and blood and urine testing for BBVs.[54] National results tested 217 women prisoners in total in the four surveys across 2004-2013, and only identified one woman with HIV antibody prevalence.[54] For women who were injecting drug users, the

national prevalence of Hepatitis C prevalence ranged from 67-83% in the survey years, and from 0-13% amongst women who had never injected drugs.[54]

Western Australia aims to test for BBVs and sexually transmitted infections (STIs) in all prison entrants.[55] An audit of testing conducted for all prison entrants in Western Australia across 2005-2007 found half of all prisoners were tested for at least one STI and nearly 40% for at least one BBV, however, completeness of testing varied by sex, age, Aboriginality, and location.[55] These findings are similar to another cross-sectional audit of health of 170 male and 15 women prison entrants in Western Australia in 2006, which found 43% of entrants were screened for BBVs and STIs in their first month of prison reception.[56]

Fertility and contraception

Australian women prisoners become mothers at younger ages and have more pregnancies than the general population,[57-59] which may then contribute to intergenerational impacts of maternal incarceration.

Teenage pregnancy is common amongst imprisoned mothers, with around 40% of Western Australian imprisoned mothers in 2008 reporting having given birth to their first child when they were aged less than 18 years.[30] In comparison, only 4% of Australian women gave birth to their first child aged 20 years or less, with the average age being 28.2 years,[60] compared to the average age of 19 years for women prisoners generally, and 17 years for Aboriginal women compared to 20 years for non-Aboriginal women prisoners.[60]

There are limited data available in Australia on rates of pregnancies in the women prisoner population that are unplanned,[61] although there is some evidence that the history of pregnancy terminations is higher for women prisoners than general community women.[57, 62]

Within a longitudinal cohort study of a sample of 251 female prisoners aged less than 50 years at time of first imprisonment in Queensland between 2008 and 2010, only two women were taking prescribed contraceptive medication while in prison (<1%).[61] Six-months after release from prison, post-release contraceptive medication had been dispensed to 19 women (7.6%).[61] Around half (n=9) were prescribed oral contraceptives

and the other half (n=10) were prescribed long-acting reversible contraceptives.[61] Seventeen of the 19 women were non-Aboriginal.

2.4.3 Socioeconomic characteristics of the women prisoner population

Education and employment

Low levels of education and employment are common issues within the women prisoner population. Half of Western Australian women prisoners in 2008 had not completed Year 10 at secondary school compared to one-quarter of women in the general Western Australian population.[30, 63]

Aboriginal women prisoners have received less education than non-Aboriginal women prisoners in Western Australia. In 2012-2013, nearly twice the proportion of Aboriginal women prisoners (41%) had not completed year 10, than non-Aboriginal women (22%).[31] Over twice the proportion of non-Aboriginal women (24%) had received a college certification, diploma or trade qualification, than Aboriginal women (11%).[31]

In 2008, the majority of women prisoners in Western Australia were not employed before their imprisonment, with only 20% having a history of consistent employment.[30] In the month preceding imprisonment in 2012-2013, 80% of Western Australian women prisoners received income from Centrelink, 13% from paid work, and 9% from illegal activities.[31]

Housing and homelessness

Prior to imprisonment in 2008, a quarter of the Western Australian women prisoners did not have stable housing.[30] Although the majority of women (92%) reported they knew where they would live on re-entry into the community, which was mostly with family (51%), one-tenth of women were relying on services once they were released to find temporary accommodation.[30]

This is potentially a significant issue for children of incarcerated mothers as often women cannot regain custody of their children on release from prison without stable housing. An inability to secure housing post-release can contribute to women returning to former abusive partners or to acquaintances related to their offending histories. Given this, housing support for incarcerated mothers post-release is recognised as a key issue for their children and for recidivism.[64] The importance of providing support services tailored specifically to Aboriginal women's needs has also been highlighted.[64] Within

Australia there is not an adequate or consistent approach to provision of services between States.[65] Australian research has also found that unstable housing arrangements post-release is a predictor for recidivism, and that women experience greater difficulty securing housing than male prisoners.[65]

Social resources

Two thirds of Western Australian women prisoners in 2008 were in relationships before their imprisonment.[30] For those women in a relationship before their imprisonment, one third reported that the relationship had ended since their imprisonment.[30]

Non-Aboriginal women prisoners in Western Australia were more likely (33%) to describe their relationship with their family prior to their imprisonment as 'distant' or 'estranged', than Aboriginal women prisoners (19%).[30] Similar rates of Aboriginal and non-Aboriginal women prisoners, however, reported their primary carers in childhood were foster families (19% Aboriginal and 12% non-Aboriginal).[30]

Most women prisoners in Western Australia in 2008 reported having friends who had engaged with the criminal justice system, and this was the case for 74% of Aboriginal women and 54% of non-Aboriginal women.[30] Additionally, 96% of Aboriginal women prisoners and 32% of non-Aboriginal women prisoners reported having family members involved in the criminal justice system.[30]

2.4.4 Key features of incarceration and offending

Incarceration and offending profile

There are marked differences between the types of offences Aboriginal and non-Aboriginal women prisoners have committed.[66] Non-Aboriginal women are primarily imprisoned for drug offences (25%), fraud related offences (12%), homicide (11%) and offences against justice procedures (10%). Aboriginal women are, however, more likely to be in prison for acts intended to cause injury (34%), unlawful entry of premises (15%), offences against justice procedures (9%) and robbery (9%).[66]

Only 3.6% of Aboriginal women are imprisoned for drug offences, although similarly high proportions of Aboriginal (77%) and non-Aboriginal (84%) women prisoners in Western Australia in 2008 reported their offending was related to drug and alcohol use.[30] The majority of women committed an offence while under the influence of drugs or alcohol, or to obtain drugs. A higher proportion of non-Aboriginal women's

offending was related to selling drugs (34%), when compared to only 4% of Aboriginal women.[30]

In 2008, most of the women prisoners surveyed in Western Australia had been imprisoned at least once before (69%).[30] Around a third of women had spent more than a fifth of their adult lives in prison. For their current term of imprisonment, 14% were on remand, 9% were sentenced to less than 6 months, 11% between 6 months and 1 year, and 52% between 1 and 5 years. Aboriginal women were more likely to be on remand (16% vs. 12%) and to have shorter sentences less than 12 months (28% vs. 12%) than non-Aboriginal women.[30]

In Western Australia, prisoners sentenced to spend less than six months in prison are, in general, not provided with a management plan or access to education and treatment programs.[67] For women prisoners who are more likely to be imprisoned for relatively minor offences, despite offending being related to alcohol or substance use, this means many women are not able to access appropriate treatment services.[67, 68] One study of 41 female parolees in Western Australia who had breached their parole conditions, found 93% of women had breached parole due to alcohol or other substance use (including failure to present for substance use testing).[67] In that study only 16 of the 41 participants were likely to be offered access to substance use treatment programs during their imprisonment based on their sentence length.[67]

Vulnerability following release from prison

Women are particularly vulnerable following their release from prison and re-entry into the community.[31, 69] The majority of women prisoners in Western Australia are imprisoned for relatively short sentences that often preclude them from being eligible for treatment programs that are particularly important for women given their complex mental health needs including high prevalence of substance use disorders.[69]

When asked what services they required to avoid returning to prison, the key service areas identified by Western Australian women prisoners in 2008 were employment (38%), substance abuse counselling (34%), housing (21%), other forms of family support (21%) and ongoing counselling within the community (19%).[30] A quarter of women reported that generally they needed to "stay away from bad influences" in order to avoid returning to prison.[30] Around a third did not think that any services would be

necessary as they believed they would be unlikely to reoffend and 7% felt the programs they received in prison were sufficient for their rehabilitation.[30]

The majority (81%) of imprisoned mothers surveyed in Western Australia in 2008, were planning to resume care of their children upon re-entry into the community. However, there were potential indications of maternal stressors that might impact mother's successful re-entry. For instance, half of the women in the survey who had been in a relationship prior to their imprisonment reported that they would not continue any affiliation with this partner when released from prison. There were multiple reasons given for this, including death, subsequent imprisonment of the partner or as a conscious decision to break connections related to their previous offending.[30]

Qualitative research conducted in Victoria through the Surviving Outside project has explored women's post-imprisonment experiences of mortality.[70, 71] Thirty interviews were held with female ex-prisoners and prison support workers. They describe an interrelatedness between past trauma and subsequent criminalisation as well as inflicting harm upon themselves, family and others. They found that even many survivors reported near death experiences following their release.[70] There is growing research that prisoners generally have an increased risk of death after their release, particularly within the first month and often relating to drug use.[72]

Research in Western Australia and New South Wales has shown this trend exists for women prisoners similarly to male prisoners, with an observed crude mortality rate of 6.78 per 1,000 person-years for female ex-prisoners in Western Australia within a year of their release and 8.97 per 1,000 person-years for female ex-prisoners in New South Wales.[72] The same tendency for deaths to occur soon, within the first two months, after imprisonment was seen for females as for males. However, unlike the international literature they did not find any relationship that the deaths generally (male and female considered together) were drug-related.[72]

2.5 The prevalence and characteristics of children of incarcerated mothers

This section provides an overview of the population statistics available for the children of women prisoners in Australia.

2.5.1 Prevalence of children affected by maternal incarceration

The parental status of prisoners or details of their children are not routinely recorded in national or State level population statistics in Australia.[73]

The most relevant national health statistics were collected by the Australian Institute of Health and Welfare (AIHW) through a survey of 794 prison entrants in 2012. The data showed that 35% of the respondents had children who depended on them for their basic needs.[74] Around 20% of participants in this survey, however, failed to respond to the particular question of their parental status prior to prison entry. A proportion of prison entrants (21%) had parents who were imprisoned (16% father, 2% mother, 3% both) when they were a child.

Estimates of the number of children affected by maternal incarceration have been made for several Australian States. Quilty et al.[75] used a cross-sectional survey of prisoners in New South Wales to estimate that 57% of women incarcerated in 2001 were mothers to 2,253 children under the age of 16-years (161 per 100,000), with a total of 9,967 children in 2001 having experienced the incarceration of their mother. The same survey found that 49% of imprisoned men were fathers to 12,266 children (875 per 100,000) under 16-years of age. Quilty et al[75] also found that Aboriginal women prisoners were more likely to be mothers than their non-Aboriginal counterparts. Aboriginal children were 13-times more likely to experience the incarceration of their mother at the time of the survey (1,449 per 100,000), than non-Aboriginal children (112 per 100,000), reflecting both the higher rates of female imprisonment of Aboriginal women and their greater likelihood of being mothers.

The Department of Corrective Services[30] in Western Australia conducted in-depth interviews with 64 female prisoners under the 'Profile of Women in Prison Project' in 2008. This represented a response rate at 74%, including 65% of Aboriginal women and 84% of non-Aboriginal respondents. This survey found that 61% of incarcerated women in Western Australia had children who were under 18 years of age.

In 2005 the South Australian Attorney General's Department administered a prison census to ascertain the parental status of prisoners.[76] Only 28% of prisoners responded to the census. While 83% of respondents reported that they had children, the sample included only 16 women and is therefore of limited use. Major contributors to non-

response in the inmate population include mistrust of prison authorities and researchers, fears over privacy and illiteracy.[77, 78]

2.5.2 Demographic characteristics

Without routinely collected population level data, there is no clear profile of the characteristics of the population of children affected by maternal incarceration in Australia. Details such as family structure and living arrangements during imprisonment have been the subject of Australian research by Flynn.[79] However, there is generally little to no evidence related to details of a child's age at the time of first imprisonment, the frequency or total amount of time their mother is imprisoned throughout their childhood, child protection system involvement, instances of abuse or neglect, or health and mortality outcomes.

2.5.3 Children's experience of maternal incarceration

If and how children are impacted at each of the various stages of their parent's exposure to the criminal justice system, depends on a range of characteristics and circumstances of the child, parent, and justice and child protection systems.[80]

Arrest

Mother-child separation can often be abrupt, particularly if the mother is placed on remand immediately following arrest. The literature on attachment theory holds that parent-child separations that are sudden, frightening or unexplained are more likely to disrupt a child's attachment as compared to separations that are planned and explained in developmentally appropriate terms.[81]

Sentencing

Across all Australian jurisdictions, judges can take potential hardship to the offender's dependent children into consideration in their sentencing decisions.[82] However, in practice children's hardship is only taken into consideration in 'exceptional circumstances'.[82] A review of sentencing appeals held in Australian states and territories between 2000 and 2014, identified 85 cases where hardship to the defendant's children was a factor considered on a sentencing appeal.[82] Of these cases, 51 related to female defendants, with 16 women being pregnant at the time of appeal and 20 having children aged less than one year.[82] Seven of the women were known to be Aboriginal and 28 women were single parents. Of the 85 cases reviewed, 16 of the appeals determined that

the hardship posed to the defendant's children constituted 'exceptional circumstances' and resulted in changes to the sentence on appeal including either the parent's immediate release and sentence suspension, or a reduction in the sentence, depending on the nature of the situation.[82] What were considered 'exceptional circumstances' predominantly included either serious child illnesses and disabilities or having no alternative carer available.[82] There were, however, many instances of child illness, disabilities or having no alternative carer apart from state care, which were not deemed to constitute 'exceptional circumstances' on appeal.[82] Pregnancy or breastfeeding infants were not on their own, considered to meet the 'exceptional circumstances' test.[82]

Maternal imprisonment, care arrangements and visitation

Children's experience of maternal imprisonment will depend on multiple factors including their age, developmental stage and temperament, their relationship with their mother, their alternative care arrangements, the length and circumstances of their mother's imprisonment and the quality and accessibility of supportive programs and services.

In a study of 54 children aged between 2.5 and 7.5 years who were separated from their mother due to incarceration in the United States, Poehlmann[48] found the most common reactions children experienced were crying, sadness and/or repeatedly calling for and looking for mothers (83%), confusion (52%), anger (40%), indifference (33%), sleep disturbances (32%), developmental regression (22%) and fear (18%). With the majority of children (83%) experiencing multiple reactions.[48]

As noted above, the parental status of prisoners is not routinely obtained in Australian prisons and so details of children's care arrangements during their parent's incarceration are established through research and prisoner surveys.[79] The Department of Corrective Services[30] in Western Australia conducted in-depth interviews with 64 female prisoners. Of the women with children aged less than 18 years, 66% had custody of all their children before their arrest, 29% did not have custody of any of their children and 5% had custody of some of their children. Of those women who cared for their children before arrest, one quarter cared for four or more children. During their mother's imprisonment non-Aboriginal children were more likely to be cared for by their father or mother's partner (53%), or by their mother's parents (37%). In contrast Aboriginal children were more likely to be cared for by other family members, not including the

mother's parents or partner (63%). The majority of mothers (81%) reported that they intended to take over the care of their children after their release.[30]

Disruption in care arrangements can cause disturbances in children's lives such as dislocation from siblings and other family members and changing schools.[79] Many children may already be living in situations of unstable care, potentially related to their parent's offending. Sheehan[83] conducted a study of 156 children who came in contact with the Melbourne Children's Court in relation to child protection matters and had a parent previously or currently incarcerated or convicted awaiting sentencing. One third of the children in the study were in foster care, one third living with grandparents, one sixth with their mother and the remainder with other relatives or friends, with children of imprisoned mother's being most likely to be in foster care.[83] They described children as commonly lacking stability in their home environment, finding that very few siblings lived together and many were moved frequently between relatives or out of home care.[83] The lack of stability over living arrangements was presented specifically to the Court as being a concern in the related child protection matter for a quarter of the children.[83]

Generally, disruptions in a child's care arrangements, in combination with separation from their primary caregiver may interfere with their developmental outcomes.[84] Maintaining contact through prison visits may assist children in coping with maternal separation and helping to maintain healthy attachment relationships.[48] However, there are many barriers to children being able to make regular visits to prison and other potential sources of stress or harm during visitation.

In the Western Australian Department of Corrective Services[30] survey of women prisoners, two thirds of mothers reported that their children visited them regularly. Of the mothers who didn't receive visitors, the main reasons reported were that they did not want visitors to see them, that they were having problems with family or that the distance required for visitors to travel to the prison was too far.[30] Other barriers to visits that have been described include restrictions over visiting times, number of visitors allowed at one time, security screening procedures being potentially traumatic for children and inadequate physical environment or provision of activities for children.

2.5.4 Overlap with child protection system

There will be a significant crossover between the child protection and criminal justice systems for many families affected by parental incarceration. In the United States, a study into the implications of this crossover, reviewed child protection case records for children with parents also involved in the criminal justice system and proposed four key areas of intersection:

> (1) instances in which parental arrest and child maltreatment investigations coincide;
>
> (2) consideration of parents' criminal histories in the decision to remove children from the care of their parents;
>
> (3) consideration of relatives' criminal histories in decisions to place children in foster care; and;
>
> (4) instances in which child protective services agencies become involved with children whose parents are incarcerated because of risks to children's current safety or inadequate resources.[85]

A similar study has been conducted in Australia, which focused on children in contact with the Melbourne Children's Court for child protection matters whose parent was previously or currently in prison, or awaiting.[83] The key reasons the child protection matters were in Court were parental drug and alcohol abuse, transience, neglect, emotional abuse and family violence.[83] A third of children were brought to the attention of the Court for the first time before they were two years old. Around a third were placed under the care of child protection services. Children aged between 6-10 years whose mother had a history of imprisonment were highlighted as a particularly vulnerable group with the highest levels of intervention and fragmentation of care.[83]

The study reported there was *"no co-ordinated response by the child protection and justice systems to managing these children's situations"* and that the current model did not adequately meet the needs of this population of.[83] The author found both the child protection and prison systems to be focused primarily on immediate circumstances, and did not adequately address the ongoing nature of the difficulties commonly experienced by these families.[83]

There are no routinely collected population surveillance data on the proportion of Australian children of prisoners who are also in contact with the child protection system or the relationship between parent's offending or imprisonment and child protection

interventions. In the 2013 survey of Western Australian women prisoners, 48% of non-Aboriginal women and 27% of Aboriginal women prisoners had children removed from their care at some time.[31]

2.6 Outcomes for children of incarcerated mothers

This section first provides a broad overview of the literature on the outcomes of children of women prisoners, and second a review of the literature which specifically relates to the infant mortality and low birth weight outcomes of infants born to women imprisoned during their pregnancy.

2.6.1 Broad literature on child outcomes

There are two approaches to conceptualising the outcomes experienced by children of prisoners. Some authors focus on assessing whether there is a causal link between the direct effects of parental incarceration and the outcomes for their children, which requires controlling for the effects of pre-existing family factors. Others address the totality of outcomes that children experience due to the combination of their vulnerable family environment and parental incarceration. The second approach is more aligned to the concepts articulated in the Developmental Origins of Health and Disease framework, that demonstrate the impact that cumulative adversities have on future health risk.

Many studies of children of prisoners have focused on their behavioural and psychological outcomes including formation and maintenance of secure attachment in infants and young children, delinquency and educational difficulties in adolescents.[89] The aim of these studies is to determine if parental incarceration has a causal effect on the development of those outcomes, over and above the effects of pre-existing disadvantage.

The majority of the literature on the outcomes of children of prisoners has been conducted in the United States, United Kingdom and Europe,[89] with fewer studies within Australia. Some factors which are important to the transferability of findings between jurisdictions include the demographic characteristics of offenders, their reasons and motivation for offending, sentencing approaches for particular offences and offender histories, and average length of sentences.

Literature on the outcomes of children of prisoners has largely focused on either paternal or parental incarceration, with less separate consideration for the children of incarcerated mothers.

The interaction between mothers and children are particularly important for infants.[84, 86, 87] Infants of incarcerated mothers are at particular risk of a disruption of attachment relationships with their mother if they are separated by their mothers' imprisonment.

In this context, the prison environment provides an important opportunity to support mothers to form healthy attachment relationships with their young children, by addressing their own relational history, the common drug and alcohol and mental health burden and facilitate more nurturing ways of being with their child. Research by Byrne et al.[86] conducted in the United States has shown that infants raised in a prison nursery can achieve secure attachment relationships to their mothers at rates comparable to those in the community, *"even when the mother's own internal attachment representation has been categorised as insecure"*.

For older children of prisoners, the literature has focussed on behavioural problems, including delinquency, and educational problems including school retention. Cho[88] analysed data from 9,563 children in the United States who were between 5 and 17 years of age at the time of their mother's imprisonment and used sibling pair samples to control for family characteristics. They found a high rate of school dropout, with 43% of adolescents not completing high school. They also found that adolescents were at an increased risk of school dropout during their mother's period of incarceration and that children who had been removed from mothers' guardianship and placed with a relative experienced greater rates of school dropout than those who remained in their mother's custody.

Murray, Bijleveld, Farrington and Loeber[89] have undertaken extensive research into the effects of parental incarceration on children based in England, Sweden, the Netherlands and the United States. They cite four theoretical frameworks for understanding why and how parental incarceration might have adverse effects on children: including a review of attachment theory, strain theory, social learning theory, and stigma or labelling theory. They draw on ecological theory to explain how context may modify the effects of parental incarceration on children. They also consider the issue from a 'selection perspective', that parental incarceration might not cause adverse outcomes for children

if children with incarcerated parents were already at risk before their parent was incarcerated. As they state; *"parental criminal behaviour, parental mental illness, and other environmental influences before parental incarceration might explain children's outcomes, rather than the incarceration itself"*.[89]

In general, this research found that parental incarceration has no effect on children *"over and above the effect of pre-existing disadvantage"*.[89] Alternatively, there is literature on Adverse Childhood Experiences (ACEs), which considers parental criminality or imprisonment as one of the measures of 'Household Dysfunction' that are combined with measures of 'Childhood Abuse' to attribute individuals with an overall 'score' of the number of ACEs experienced in childhood.[90] These studies find a cumulative impact of the number of ACEs experienced and a range of poor health outcomes, including mortality.

The research considers that *"cumulative exposure to traumatic stress during childhood is consistent with recent understanding of the effects of traumatic stress on neurodevelopment"* linking *"childhood maltreatment to long-term changes in brain structure and function", "lasting alterations in stress-responsive neurobiological systems, and these lasting effects on the developing brain would be expected to affect numerous human functions into adulthood, including emotional regulation, somatic signal processing, substance abuse, sexuality, memory, arousal, and aggression"*.[91] The inclusion of parental incarceration in this framework seems logical given the impact of parental incarceration, as captured in the main theories explored by Murray, Bijleveld, Farrington and Loeber.[89]

2.6.2 Infant mortality and low birth weight outcomes for children of mothers imprisoned during pregnancy

Infants born to mothers who are imprisoned during pregnancy are a unique group who warrant separate consideration, given the importance of normal infant development for adult health and wellbeing.

There have been several systematic reviews of the literature related to risk factors in pregnancy, perinatal outcomes, and health service provision for imprisoned pregnant women. In this section, the main findings of these reviews are summarised followed by a comparison of the findings of studies which have compared the infant mortality and/or

low birth weight outcomes for infants whose mothers were imprisoned during pregnancy to disadvantaged or population controls.

Key findings from existing systematic reviews on pregnant prisoners

There have been several systematic reviews of literature relating to pregnant prisoners. These have covered their risk factors,[92] their perinatal outcomes,[93, 94] experiences and interventions,[94] and health care service provision.[95] All reviews have noted a general lack of available studies on the pregnant prisoner population and that the quality of existing studies is generally poor, with small samples, poorly defined and inconsistently measured outcomes.

Risk factors

Knight and Plugge[92] conducted a systematic review to identify risk factors associated with adverse perinatal outcomes within the population of imprisoned pregnant women. The review of studies published between 1980 and mid-2004, identified 27 relevant papers of which 13 met the inclusion criteria that studies describe any of a set of prespecified perinatal risk factors for women who were imprisoned at any stage during their pregnancy.[92]

The 13 studies included a total of 1504 women imprisoned in pregnancy and 4571 population control women. Eleven of the studies were set in the United States, one in the United Kingdom and one in Germany. Seven studies were cohort study design and six were case series. Ten studies included population controls.

Risk factors that affected more than half of the pregnant prisoners included single marital status (84%), non-white race (67%), smoking (66%), not completing secondary schooling (54%), and substance use (54%), as displayed in Table 2.4 below.

The risk factors that were investigated in studies which included a population control group, are displayed with their associated odds ratio in Figure 2.1. Women who were imprisoned during pregnancy were significantly more likely to be affected by all of the eight risk factors. Notably, drug use (OR 25.86, 95%CI 14.06-47.57) and alcohol use in pregnancy (OR 4.82, 95%CI 3.23-7.19) were significant risk factors for pregnant prisoners.

Table 2.4 Risk factor profile of imprisoned pregnant women (Knight & Plugge[92])

Risk Factor	Number of women studied	Number of studies	Percentage of imprisoned pregnant women with identified risk factor
Single marital status	997	7	83.7
Non-white race	1042	10	66.7
Smoking	838	8	66.0
Not completed high school/ A levels	529	6	54.4
Drug use	646	7	53.7
Inadequate prenatal care	704	6	30.5
Primiparity	944	8	26.7
Previous low birth weight infant	88	1	25.0
Alcohol use	363	4	19.8
Prior preterm delivery or mid-trimester loss	428	3	15.9
Maternal medical problem	100	2	11.0
Age over 40	233	1	2.6
Previous stillbirth or neonatal death	298	1	1.3

Note. reproduced from Knight and Plugge[92]

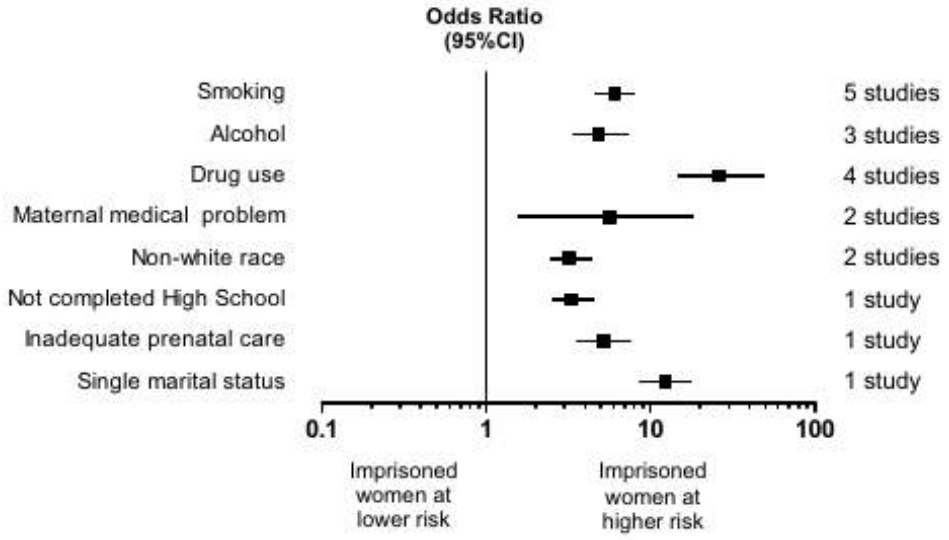


Figure 2.1 Summary of odds ratios for risk factors for poor perinatal outcomes for imprisoned pregnant women compared to population controls (Knight & Plugge[92])

Knight and Plugge[92] concluded that women who are imprisoned during pregnancy are a population at high risk of developing obstetric complications and experiencing poor perinatal outcomes. Despite their high-risk status, it was found that nearly one third of pregnant prisoners received inadequate prenatal care.[92]

Perinatal outcomes

Knight and Plugge[93] also conducted a systematic review of the literature with the purpose of investigating the association between imprisonment during pregnancy and selected perinatal outcomes including perinatal or infant death, stillbirth, preterm delivery, low birth weight, fetal anomalies and use of breast milk substitutes. The findings relating to infant mortality and low birth weight outcomes are discussed in detail in the next section (Section 2.6.3).

Knight and Plugge[93] identified 28 relevant papers published to May 2005, of which 10 met the inclusion criteria. Studies without a valid comparison group were excluded. The studies included 1,960 women imprisoned in pregnancy and 10,858 control women. The control women were assessed by two main groups including 1,209 disadvantaged control women and 9,649 general population control women. The disadvantaged control group consisted mainly of women who were imprisoned at times other than pregnancy and a small number of whom were enrolled in a methadone maintenance program (n=47). In general, there was a difference seen when comparing outcomes for women imprisoned during pregnancy to disadvantaged or population control women. Women imprisoned during pregnancy were more likely to have a preterm birth or low birth weight infant than general population control women. However, this trend was reversed when comparing outcomes for women imprisoned in pregnancy to disadvantaged controls, with imprisoned women being less likely to have a stillborn or low birth weight infant. It was postulated that this indicates a beneficial impact of imprisonment on perinatal outcomes. None of the studies reported infant deaths. Two studies reported neonatal deaths, however, there were only 4 observations in total.

See Figures 2.2-2.5 for the summary of findings for stillbirth, preterm delivery, low birth weight and mean birth weight outcomes reported across the studies.

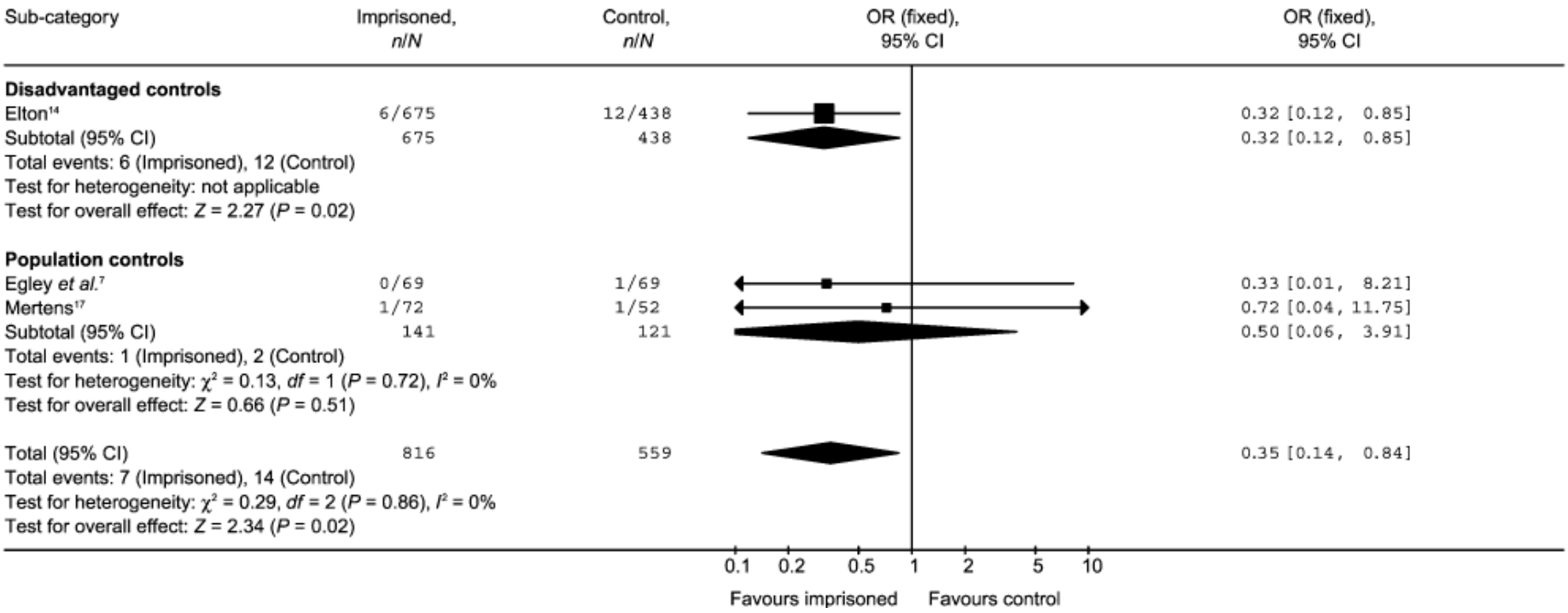


Figure 2.2 Summary of literature on stillbirths (Knight & Plugge[93])

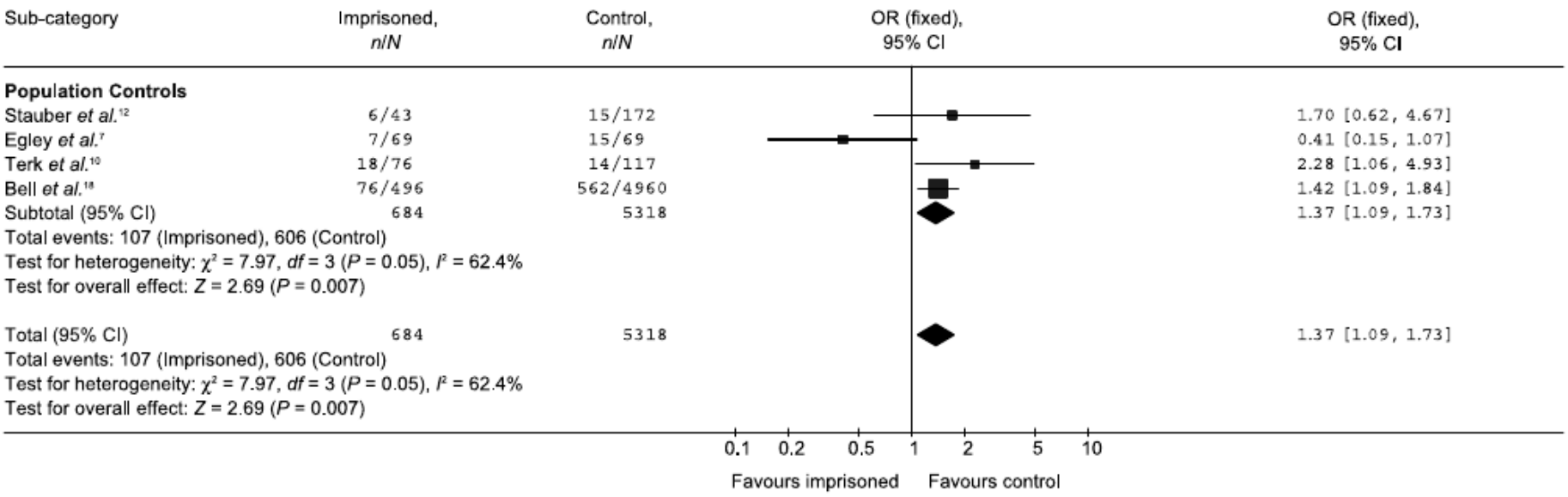


Figure 2.3 Summary of literature on preterm delivery (Knight & Plugge[93])

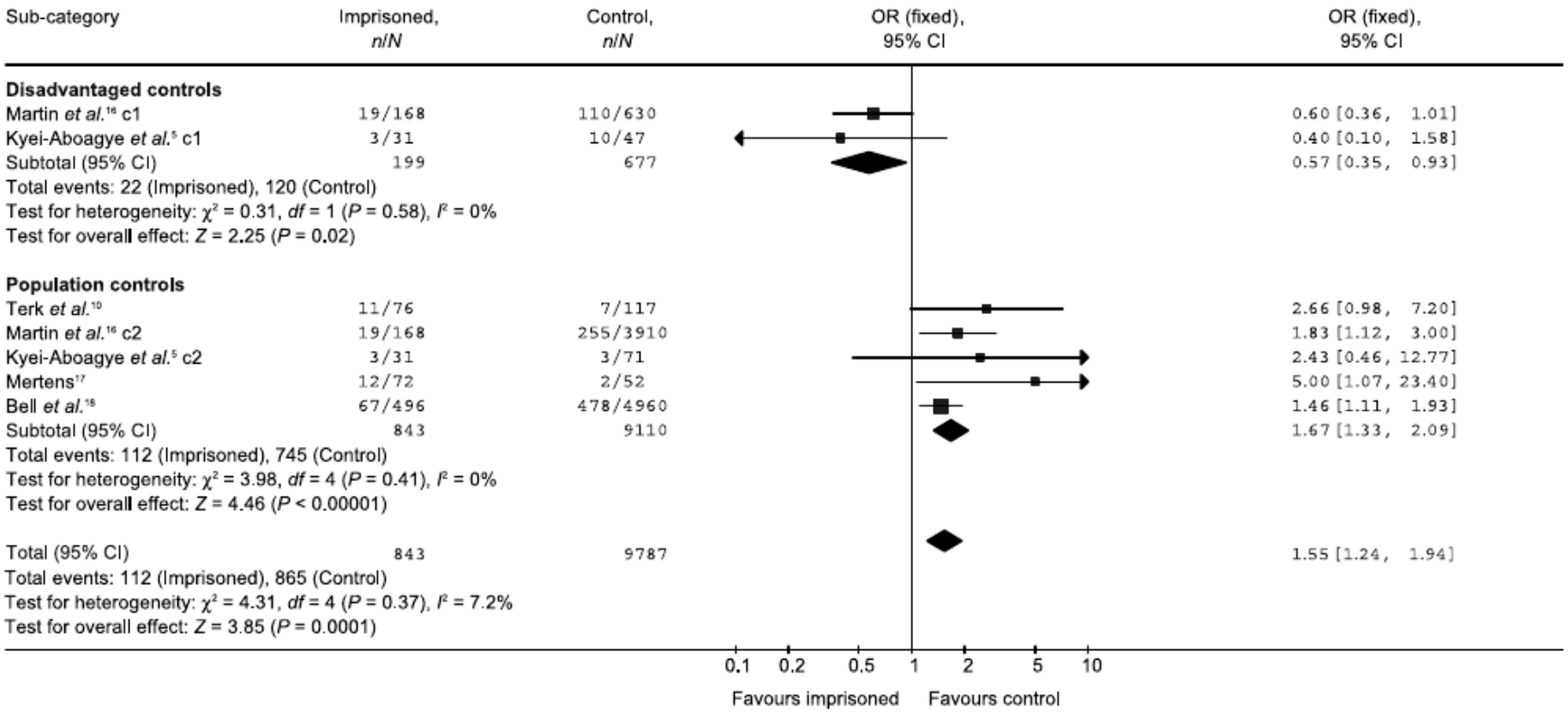


Figure 2.4 Summary of literature on low birth weight outcomes (Knight & Plugge[92])

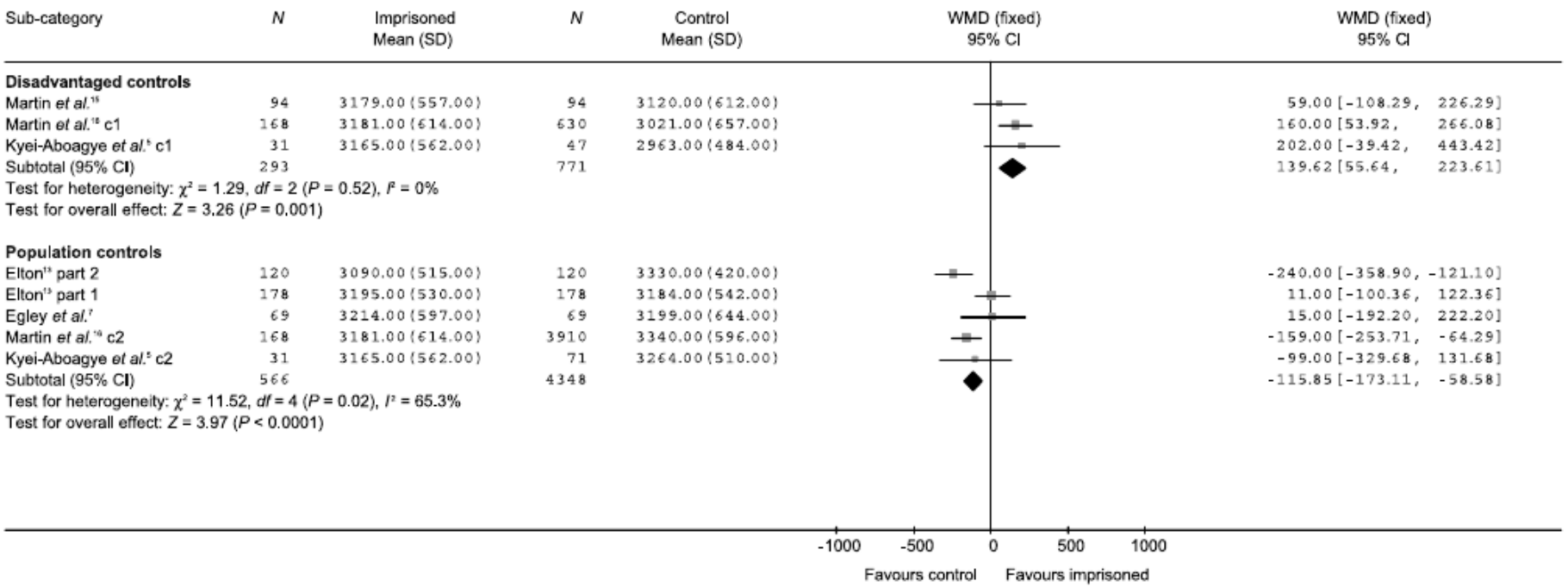


Figure 2.5 Summary of literature on mean differences for birth weight (Knight & Plugge[92])

The impact of perinatal health care services for women prisoners

There have been two systematic reviews conducted recently which have focused on the experience and outcomes of maternity care for women prisoners.[94, 95]

Shaw, Downe and Kingdon[94] conducted a systematic review of quantitative and qualitative studies reporting maternity experiences and outcomes for pregnant prisoners. The review identified 13 potentially relevant studies published from 1995 to May 2014, of which seven studies met the inclusion criteria. Six studies were conducted in the United States and one in the United Kingdom. Four studies were quantitative, two were qualitative and one was mixed-methods. The review found there are limited published data on the experiences and outcomes of maternity care for pregnant prisoners. The review considered the heterogeneity between the quantitative studies was too great to allow for meta-analysis of results relating to perinatal outcomes.

The qualitative studies were conducted in the United States and reported mothers feelings of *"apprehension, grief and loss"* at the separation from their infant after birth, and the impact of prison staff and maternity care staff can reduce or increase maternal distress.

Bard, Knight and Plugge[95] conducted a systematic review of the literature to identify studies describing models of perinatal health care services for imprisoned pregnant women, that also reported maternal, infant or care outcomes. The review identified 18 studies published from 1980 to April 2014. The majority of studies were conducted in the United States (n=15), with two studies from the United Kingdom and one from Germany. The 18 studies included 2001 imprisoned pregnant women. Half of the studies contained a comparison group, including in total 849 comparison women. The authors found study quality was variable and outcomes reported inconsistently.

Bard, Knight and Plugge[95] categorised studies by three groups according to the nature of the care for pregnant women in prison. The groups comprised of usual care (PRISON),[96-102] some evidence of enhanced care (PRISON+),[103-108] and interventions which included enhanced care in prison and coordination of community care following prison release (PRISON++).[109-113] Again, the studies generally had small sample sizes, lack of data and poorly designed programs and evaluations.

In the PRISON studies women were generally provided with antenatal care in prison by members of the prison or external health services and were transferred to the prison hospital or community hospitals for the birth. Some programs within the PRISON+ studies included access to doulas or similar birthing support workers before, during and after birth.[95] Other PRISON+ programs addressed factors such as nutrition, physical demands, counselling and education, separate accommodation from other inmates, and a specialised program for women at risk of delivering a HIV-positive infant.[95] The PRISON++ studies included programs where pregnant prisoners were provided with alternative accommodation during pregnancy and co-residence with their infant after birth, such as prison nursery programs, and where women were linked with community services following their release.[95]

In comparing the outcomes for pregnant prisoners who received usual care (PRISON) to those receiving enhanced care (PRISON+), there was evidence enhanced care improved preterm delivery (19.0% v 6.4%, p=.001) and caesarean delivery outcomes (26.5% v 12.9%, p=.005), and reduced experience of 'inadequate prenatal care' (30.7% v 15.4%, p<.001).[95] Two of the five PRISON++ intervention studies reported reductions in long term recidivism for women who participated in the interventions compared to pregnant prisoners at the same prisons who did not receive the interventions (summary OR 0.36, 95%CI 0.19-0.70).[95]

2.6.3 Literature review on infant mortality and low birth weight outcomes for pregnant prisoners

The aim of this review is to place the studies reported in this thesis within the context of the relevant literature. Accordingly, this review focuses on the key outcomes of low birth weight (<2500g) and infant mortality (death of a liveborn infant before reaching 12 months of age), and is limited specifically to cohort and case-control studies with a valid comparison group.

Infant mortality

The systematic review by Knight and Plugge,[93] discussed above, also investigated the association between maternal incarceration during pregnancy and perinatal outcomes, including infant death and low birth weight. The review included cohort and case-control studies published to the end of May 2005 and identified no studies including infant death as an outcome. An additional search of the literature after 2005 (described

below) also did not identify any studies published since 2005 which included infant mortality as an outcome.

The studies of outcomes for pregnant prisoners which included death as an outcome measure differed with respect to the inclusion of different outcomes. Outcomes measured included stillbirth (also termed fetal death), neonatal death (death of a liveborn infant before 28 days), or perinatal death (stillbirths combined with neonatal deaths). Independently of the nature of the outcome, all of the identified studies only reported only a small number of observations where death was an outcome.

Low birth weight

The following summary of the literature includes studies identified in Knight and Plugge[93] that included low birth weight as an outcome and I have included studies published after 2005 using the approach and eligibility criteria Knight and Plugge[92], as summarised in Table 2.5.

Table 2.5 Study eligibility criteria

Criteria	Inclusion	Exclusion
Population	Women detained in prison or jail at any point during pregnancy	Asylum seekers/Refugees Women detained in psychiatric hospitals
Comparison	Disadvantaged or population controls Matched or unmatched	No comparison group
Outcomes	Low birth weight (<2500g) Infant mortality (death of liveborn child aged less than 12 months)	No measure of low birth weight and/or infant mortality
Studies	Cohort or case-control studies 2005 to 27 April 2018 English language	Case studies or case series Published prior to 2005 Non-English language

Based on: Knight & Plugge[93], and Bard, Knight & Plugge[95]

I searched Medline, Embase, Emcare, Psycinfo and the Cochrane library databases, using the following search terms in any fields: ((pregnan* or mother* or matern* or antenatal) and (prison* or imprison* or jail* or gaol* or incarcerat* or inmate*) and (infant* or neonat* or postneonat* or "post-neonatal") and (death* or die*or mortality or "low birthweight" or "low birth weight" or birthweight or "birth weight" or "low-birthweight")). I also searched the reference lists of selected papers[92, 94, 95], including the other systematic reviews described in the section above.

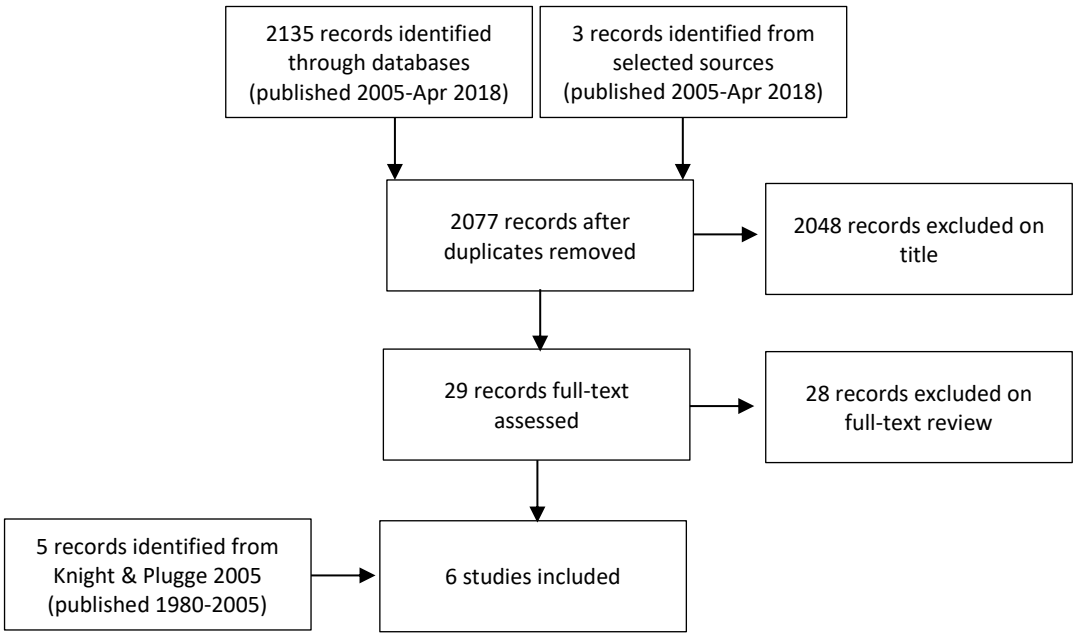


Figure 2.6 Study selection

As summarised in Figure 2.6, the search only identified one additional study[114], that had been published since the review by Knight and Plugge[93] and that met the inclusion criteria.

Six studies[97, 99, 101, 114-116] have compared low birth weight outcomes for infants of mothers imprisoned during pregnancy to disadvantaged and/or population controls. A summary of the studies (adapted from Knight & Plugge[93]) is provided in Table 2.6. One study[114] was conducted in Australia, and the remaining five studies[97, 99, 101, 115, 116] were all conducted within the United States.

Table 2.6 Summary of studies on low birth weight for women imprisoned in pregnancy

Study	Design	Setting	Participants	OR (95%CI)
Terk et al 1993[101]	Cohort	Texas, USA	76 imprisoned pregnant women who delivered at one hospital 1987-1990. 117 randomly selected women delivered at same hospital. Not matched but assessed as no statistical difference between the groups on age, race, gravidity, and parity.	Population controls: 11/76 vs. 7/117 OR 2.66 (0.98, 7.20), $p<0.05$
Martin et al 1997[116]	Cohort	North Carolina, USA	168 imprisoned pregnant women, singleton births 1988-1991. Two control groups: 630 women imprisoned 1987-1991 (not during pregnancy) and delivering 1988-1991. 3910 randomly selected women.	Disadvantaged controls: 19/168 vs. 110/630 OR 0.60 (0.36, 1.01) Population controls: 19/168 vs. 255/3910 OR 1.83 (1.12, 3.00)
Kyei-Aboagye et al 2000[97]	Cohort	Boston, USA	31 women imprisoned in second trimester who delivered at one hospital 1993-1996. Two control groups: 47 women in methadone program delivered at same hospital 71 randomly selected women	Disadvantaged controls: 3/31 vs. 10/47 OR 0.40 (0.10, 1.58) Population controls: 3/31 vs. 3/71 OR 2.43 (0.46, 12.77)
Mertens 2001[99]	Cohort	Illinois, USA	72 live births to imprisoned pregnant women from a county jail who delivered in 1 calendar year (unstated). 51 live births to women matched by age, race, gravidity and zip code.	Population controls: 12/72 vs. 2/51 OR 4.90 (1.05, 22.94), $p<0.05$
Bell et al 2004[115]	Cohort	Washington State, USA	496 singleton births to women imprisoned in county jail during pregnancy between 1994-1998. 4960 singleton births matched age, race, parity, substance abuse and smoking status.	Population controls: 67/496 vs. 478/4960 OR 1.46 (1.11, 1.93)
Walker et al 2014[114]	Cohort	New South Wales, Australia	302 births to imprisoned pregnant women aged 18-44yrs who gave birth 2000-2006. Two control groups: 1238 births to women imprisoned for at least 5 consecutive days in 2000-2006 at a time other than pregnancy. 39367 births to a representative 10% sample of women giving birth for the first time in 2000-2000, selected randomly from women in NSW who had no record of imprisonment between 1998-2006. Analyses adjusted for effects of: maternal age, smoking, parity, Aboriginal status, and mental health admission.	Disadvantaged controls: 55/302 vs. 225/1238 RR 0.93 (0.67, 1.28) Population controls: 55/302 vs. 1774/39367 RR 1.71 (1.28, 2.30), $p<0.05$

Note. Table adapted from Knight & Plugge[93]

As summarised by Knight and Plugge[93] in Figure 2.4, the studies conducted in the United States in general found that women imprisoned during pregnancy had poorer low birth weight outcomes compared to women in the general population, but better outcomes compared to other disadvantaged women who had a history of imprisonment at a time other than pregnancy. It has been proposed that this beneficial effect of imprisonment during pregnancy was likely due to an improved perinatal environment through improved access to factors such as improved nutrition and antenatal care, and reduced exposure to violent partners, alcohol and other substance use.

The only study[114] conducted in Australia found women imprisoned in pregnancy had increased risk of having a low birth weight infant compared to women in the general population women, and this study did not find a statistically significant improvement in low birth weight outcomes for pregnant prisoners in comparison to disadvantaged women who had a record of imprisonment at a time other than pregnancy. It was postulated that the basis for the differences between the studies from Australia and the United States was related to the generally shorter periods of imprisonment experienced by women prisoners in Australia compared to the US.[114] There are also important differences between the US and Australia with respect to health care accessibility, which may also contribute to the observed differences.

2.7 Summary

Incarcerated mothers are a highly disadvantaged group who experience elevated levels of trauma, mental illness, poor health, and socioeconomic disadvantage. Women's offending is often directly or indirectly related to their previous or current experiences of trauma or domestic violence and their socioeconomic circumstances, for example, offending under the influence alcohol or to obtain drugs, or in the case of imprisonment for non-payment of fines. Prison may also exacerbate and worsen women's existing level of disadvantage, such as through the retraumatising effects of imprisonment on victims of abuse, or in loss of housing and financial impacts. Alternatively, prison could potentially provide a therapeutic environment where women can address underlying disadvantage. It is the case in Western Australia, however, that many women are precluded from accessing rehabilitative programs or throughcare planning on the basis of the short-term duration of their sentence.

There is no routine collection of population level statistics on the children of prisoners in Australia. Ad hoc prevalence estimates and basic information of children's characteristics have been collected through surveys, which can be affected by issues such as low response and unrepresentative samples. Without basic population data, children of prisoners are effectively invisible from services and policy.

The overlap between maternal imprisonment and child involvement in the child protection system is likely significant, however, this has not been established or explored in Australia.

Furthermore, there is very limited literature on the impact of maternal imprisonment during pregnancy on early infant outcomes. The limited data, from the US related to birth weight suggests prison has a protective effect but this finding was not replicated in the only Australian study of this issue.

This is important because of the extensive literature on the impact of adverse experiences before birth and in early life on birth weight and survival for infants and on the development long-term health outcomes into adulthood. The DOHAD literature also explains how socioeconomic risks may operate through biological mechanisms to program or predispose individuals to poor child and adult health outcomes.

Aboriginal women and children experience significant social and economic disadvantage in Australia, stemming from the historic and continuing effects of colonisation. This disadvantage places Aboriginal women and children at increased risk of involvement in both the criminal justice and child protection systems, and contributes to a higher prevalence of low birth weight and infant mortality.

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3 A Conceptual Framework for Studies of Infant Mortality and Low Birth Weight Outcomes for Children of Women Prisoners

3.1 Introduction

This chapter outlines the conceptual framework that underpins the research studies in this thesis on maternal imprisonment as a risk factor for pregnancy outcomes including infant mortality and low birth weight, which are presented in Chapters 7-9. The purpose of the conceptual framework is to inform the basis for the studies and to help guide the selection of relevant risk factors.

The chapter first defines the key outcomes of interest, infant mortality and low birth weight. This is followed by a brief description of the process taken to develop the conceptual framework. Next the key existing conceptual framework by Mosley and Chen[1] is described in detail. Then the conceptual framework adapted from Mosley and Chen[1] framework for the purpose of the present study is outlined, including a description of how it may relate to women prisoners and maternal imprisonment.

3.2 Infant mortality and low birth weight

Infant mortality encompasses all deaths of liveborn children under one-year of age.[2] A range of factors are associated with an increased risk of infant mortality, including demographic characteristics, maternal health, behavioural and social factors, and availability and quality of health care. The importance of risk factors varies across time. For example, health care is a key risk factor for deaths within the neonatal period (0-27days), while maternal behavioural risk factors are more prominent for deaths in the postneonatal period (28days to <12months).[3, 4]

Infant mortality rates have decreased significantly over time, primarily due to improvements in sanitation, immunisation, health education, and medical care.[4, 5]

However, disparities in infant mortality rates remain between and within some population groups. As discussed in the Literature Review, women prisoners are a particularly vulnerable population and experience increased rates of exposure to many factors which may place their children at risk of poor birth outcomes, including infant mortality and low birth weight.

An infant is classified as being low birth weight if born at a weight less than 2500g.[5, 6] Low birth weight infants are at increased risk of infant mortality,[7] and of chronic disease later in life.[8] Infants may be low birth weight if they are born prematurely (before 37 weeks), are small-for-gestational-age, or both.[5] As for infant mortality, there are a range of demographic, behavioural, socioeconomic and health care factors that are associated with an increased risk of low birth weight.[5]

3.3 Process of development of the Conceptual Framework

A narrative review of the literature on the conceptual frameworks of infant mortality was conducted to identify any dominant frameworks currently in use. Searches were conducted across PubMed, Scopus, and Google Scholar using combinations of the search terms: (conceptual OR theoretical OR analytical) AND (model OR framework) AND (infant* OR child* OR neonat*) AND (mortality OR death OR survival).

Two main categories of articles were identified; i) articles presenting a conceptual framework/s or a review of conceptual frameworks, and ii) articles describing epidemiologic investigations utilising a conceptual framework. The full-text of the latter group were examined to identify whether their conceptual framework was original or based on an existing framework. A search of the grey literature included the World Health Organisation's website, as a potential source of information on the determinants of infant mortality.

It became apparent that there was a single dominant framework in common usage for explaining infant mortality i.e. the Mosley and Chen[1] framework, and that even within literature not citing Mosley and Chen there was agreement with the basic premise and structure of conceptual models of infant mortality which were used in this framework.[9-16] Specifically, there was recognition that broader determinants such as socioeconomic factors are important, as are biological risk factors, and that determinants operate through biological mechanisms to affect infant mortality risk. There were differences as

to the groupings of factors used in individual studies, which was sometimes determined by the data available to the studies.

A summary of the Mosley and Chen[1] framework, and rationale for adapting the framework for the studies contained in this thesis, is discussed below.

3.4 Summary of the Mosley and Chen (1984) conceptual framework for the study of child survival

Mosley and Chen's[1] framework is widely cited in studies of the determinants of infant mortality.[9-14, 17-19] This framework aimed to combine the different approaches to research on child survival in the social science disciplines and in the medical or biomedical sciences into a single model. As described by Mosley and Chen[1], the framework;

> …is based on the premise that all social and economic determinants of child mortality necessarily operate through a common set of biological mechanisms, or proximate determinants, to exert an impact on mortality. (Mosley & Chen[1], p.25)

There are five key sets of proximate determinants, or *"intermediate variables"*, identified by Mosley and Chen[1] as having a direct impact on children's poor health or risk of death. These are shown in grey in Figure 3.1, and include: maternal factors (age, parity, birth interval), environmental contamination (air, food, water, soil, insect vectors), nutrient deficiency (macro- and micronutrients), injury (accidental and intentional), and person illness control (prevention and medical treatment). It is through these proximate determinants, that socioeconomic determinants are said to act to impact on children.

Mosley and Chen[1] identified three-levels of socioeconomic determinants: individual (productivity of the father/mother, traditions, norms and attitudes), household (income), and community (ecological setting, political economy, health system). As depicted in Figure 3.1, these socioeconomic determinants act through the proximate determinants to exert an impact on a child's state of health, and ultimately their risk of "growth faltering" and/or "mortality". Importantly, as depicted in the model, the pathways from "sick" lead directly to mortality, and there is also a pathway to mortality via growth faltering. This provides the rationale for using the same conceptual framework for infant mortality as well as low birth weight outcomes.

The proximate determinants listed by Mosley and Chen[1] were intended to be exhaustive, *"such that child health will change if – and only if – one or more of the determinants change"*.[18] While the model provides a useful framework and tool for researchers investigating child mortality, it is proposed that the proximate determinants included by Mosley and Chen[1] require updating in light of the scientific developments that have occurred in the past three-decades, particularly those within the field of Developmental Origins of Health and Disease (as described in Chapter 2).

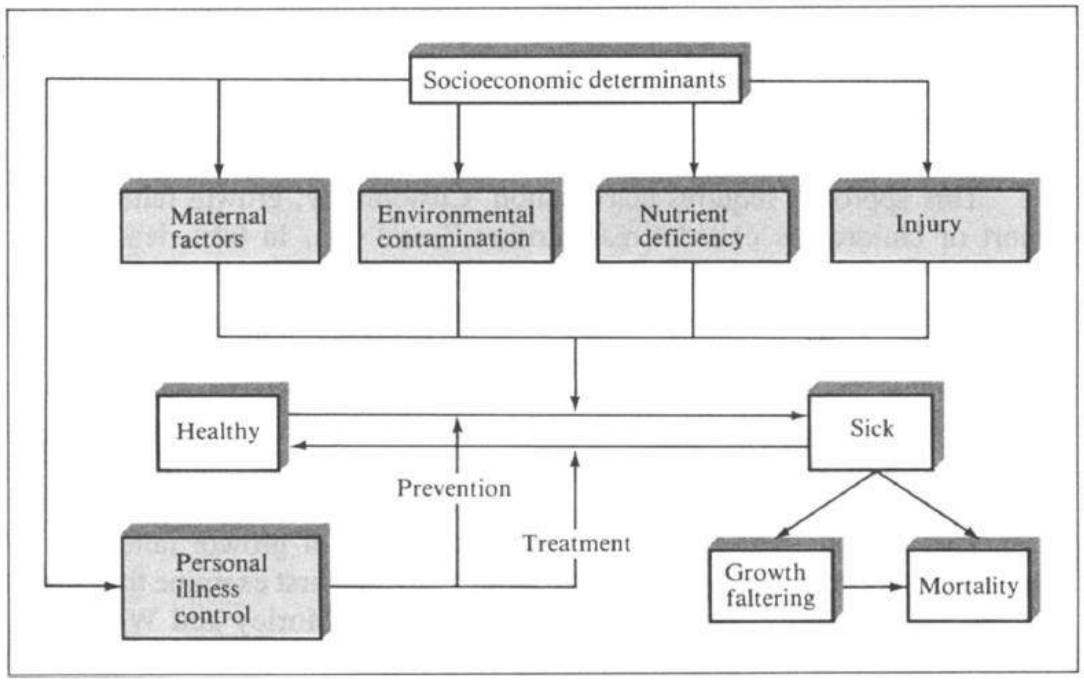


Figure 3.1 Mosley and Chen's[1] analytical framework for the study of child survival in developing countries

Six studies[9-14] were identified which have applied and adapted the Mosley and Chen[1] framework to investigate infant mortality, and a further two studies[15, 16] which although not directly citing Mosley and Chen,[1] shared similar approaches with Mosley and Chen.[1] A description of the conceptual frameworks used in these eight studies is presented in Appendix A. The existing literature on conceptual models of infant mortality is largely in agreement with the approach and content of the Mosley-Chen[1] framework. However, there are several important areas of refinement that could be considered.

First, existing frameworks do not adequately include maternal stress or trauma as risk factors for infant mortality. Based on research under the DOHAD framework (Chapter

2) stemming from the Barker hypothesis,[20-22] it is thought that epigenetic programming is a key mechanism through which many of the broader determinants, and some of the biological risk factors (e.g., trauma and stress) operate to impact on the health of the mother, fetus and infant during pregnancy and beyond into later life. This is based on evidence that 'insults' which occur to the mother early in her life and prior to her pregnancy, can result in an increased risk of poor health in offspring.[23]

Arguably in the time and context of the Mosley-Chen[1] framework, published in 1984 in the context of developing countries, discussion of determinants was more focused on environmental contamination by infective pathogens or chemicals, nutrient deficiency, and individual and household productivity. Within 'traditions/norms/culture', Mosley and Chen[1] discuss 'power relationships within the household' in terms of who makes decisions about allocation of resources (e.g., allocation of food and health care), but do not consider family violence. Maternal psychosocial stress was only considered by Myers[14] and Kim and Saada,[16] and the timing of such events were limited to exposure of the mother to stress during pregnancy in Kim and Saada,[16] and to child experience of psychosocial stress in Myers.[14] Accordingly, none of the frameworks considered the potential impacts of inter-personal violence or emotional abuse for the mother throughout the full lifecourse for the mother and child.

Similarly, the existing frameworks did not generally include factors across the lifecourse. Mosley and Chen[1] focused on the *"biological links between the mother and infant during pregnancy and lactation".* However, the subsequent DOHAD literature (Chapter 2) suggest the need to extend consideration to whole lifecourse of mother.

One note or criticism of the original terminology of "proximate" and "distal" determinants in Mosley and Chen,[1] is that it implies a hierarchical relationship, i.e. that the determinants potentially have less impact on health risk as they are "further" away. This is, however, a logical fallacy as distal determinants are considered to act directly through the biological pathways to directly influence the health state. This is now supported with the emergence of evidence from the DOHAD literature, e.g. if a stressor within the social environment generates a stress response in the mother (or infant), it is acting directly through the biological pathway to impart harm. The harm is not necessarily 'diluted' as it is transduced through the environment to the infant.

Krieger[24] has argued that use of "proximal" and "distal" terminology in such frameworks is also problematic due to "distortions created by conflating measures of space, time, level, and causal strength". The author proposes "replacing the terms proximal and distal with explicit language about levels, pathways, and power".

Accordingly, the Mosley and Chen[1] framework was adapted for the present study. The adapted framework and how it applies to women prisoners and maternal imprisonment, is described in the following section.

3.5 Development of the Conceptual framework

3.5.1 Overview of the Conceptual Framework developed for the studies within the thesis

In line with the approach taken in Mosley and Chen's[1] framework and associated literature,[9-13, 17-19] the basic premise of the conceptual framework developed for the studies within the thesis (Figure 3.2) is that broader determinants must necessarily operate through biological pathways to influence an individual's state of health and risk of infant mortality.

Rather than using 'proximate determinants', this thesis incorporates more descriptive terminology relating to the 'biological pathways and mechanisms', and includes more detail on what are now understood to be the likely biological mechanisms which may be implicated in leading to specific outcomes (e.g. genetics, epigenetic programming etc.).[23, 25-30]

As highlighted by Mosley and Chen,[1] the majority of infant mortality cases do not result from a single injurious event but from a complex set of factors and numerous biological insults over time which determine an individual's overall state of health and mortality risk. Poor fetal growth would also be a result of such processes and is therefore reflective of a compromised state of health and represents an increased risk of infant mortality.

The proposed conceptual framework which provides the context for the research studies on the impact of maternal incarceration on low birth weight and infant mortality in this thesis is provided in Figure 3.2 below.

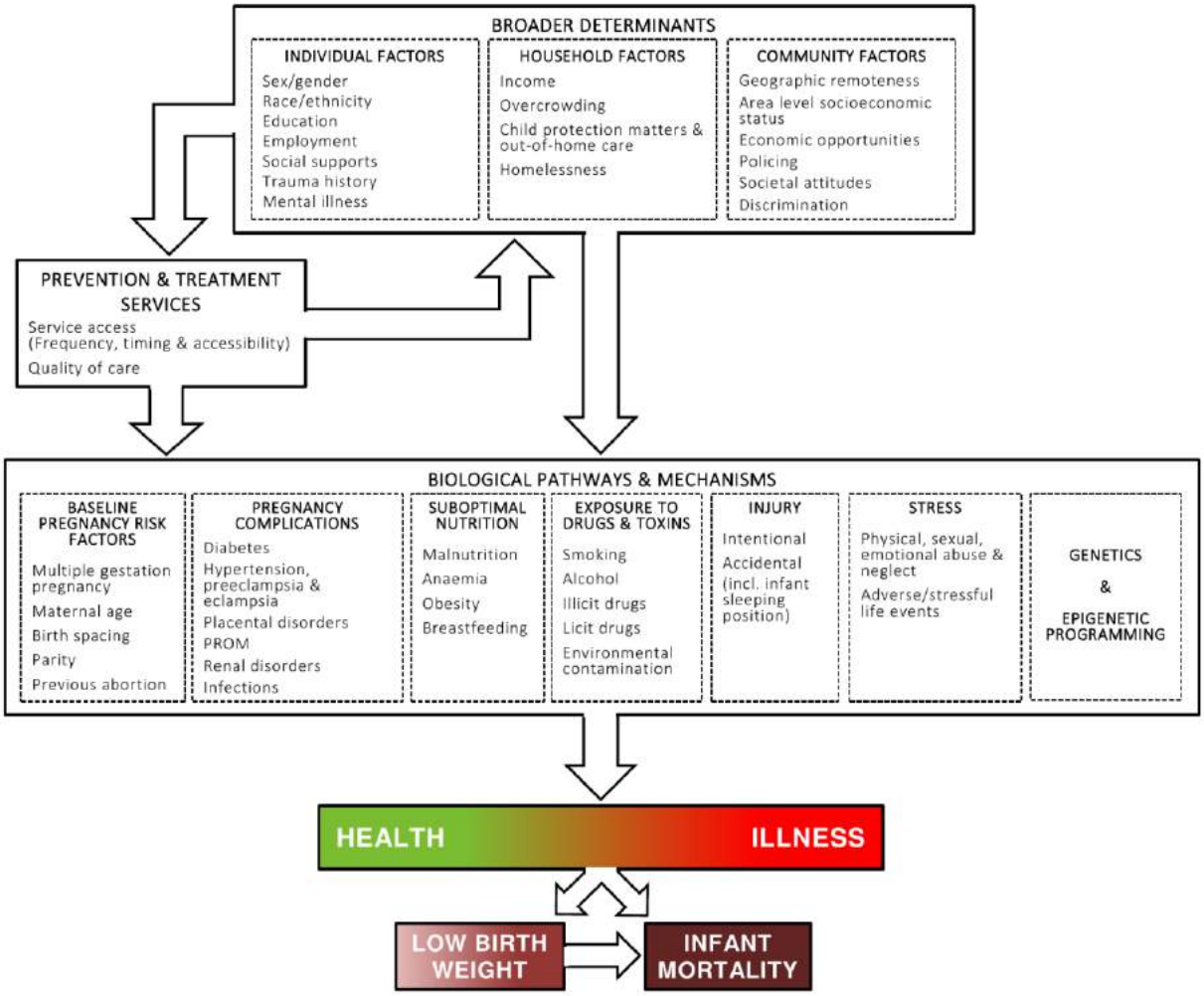


Figure 3.2 An updated conceptual framework of the broader determinants, biological pathways and mechanisms which contribute to low birth weight and infant mortality

Biological pathways and mechanisms

The framework presented here attempts to improve on Mosley-Chen[1] by providing a greater coverage of potential risk factors and has categorised the seven main groupings of factors so that they are as unique in nature as possible. The biological pathways that may be relevant to infant mortality and low birth weight outcomes include both well-established biological risk factors (e.g. multiple gestation pregnancy, exposure to toxins, suboptimal nutrition, and injury) and activation of biological mechanisms (epigenetic programming) through which risk of infant outcomes may be increased.[23, 25, 26, 28-31]

Broader determinants

The broader determinants presented in Figure 3.2 capture the factors that are known to have bearing on the biological risk factors.[16, 32, 33] I have grouped these at three-levels;

community, household, and individual with individual factors relating to both mother and the child. The traditional view of the operation of many of the broader determinants is that they impact through an effect on the mother (e.g., through an increase in maternal drug use in response to social stress) on the health of the embryo or the fetus.

Prevention and treatment services

Prevention and treatment includes contact with services that may impact directly on many of the biological risk factors or indirectly through improving the level or impact of exposure to the broader determinants. The approach represents an update from Mosley and Chen[1] in that prevention and treatment can act on both the broader determinants and directly through the biological pathways. This is particularly important in considering preventive opportunities to improve the maternal environment before pregnancy or during early pregnancy.

Services provided can be within the health sector, perhaps most importantly during the antenatal period, but also include other broader social and government services (including those experienced in prison).

Although many of the biological risk factors and broader determinants are amenable to intervention or change, it is important to acknowledge that some risk factors are not modifiable, as in the case of gender, ethnicity, and genetics.

Frequency, timing, and severity of risk factors

I have developed an additional schematic (Figure 3) to accompany the conceptual framework (Figure 3.2), to include timing of and cooccurrence of risks related to low birth weight and infant mortality. In this framework, infant mortality risk is determined by the frequency, timing, and severity of events that fall within the individual lives of mothers and infants. As depicted in Figure 3.3, broader determinants, biological risk factors, and prevention and treatment services can occur across the lifecourse of the mother and her infant.

These additions to the framework highlight three distinct critical time periods which are important in determining future health outcomes for the fetus or infant. The fetus is obviously vulnerable to adverse exposures during pregnancy, however, emerging evidence from the DOHAD literature also highlights the importance of exposure to adversity such as stress, occurring during the period before or around the time of

conception in contributing to the risk of infant mortality.[23] Within the literature there are two dominant theories as to how maternal stress may result in poor birth outcomes. The first is the importance of such events occurring at key stages of fetal development, and the second is that an accumulation of stressors increase 'allostatic load'.[34] It is also the case that the frequency and severity of events which affect a mother early in her own childhood and in the period immediately before conception increase the risk of poor outcomes for the fetus.[35, 36] After birth, the neonate and then infant is also known to be vulnerable to harm.[28]

The two primary outcomes included in Figure 3.3 are low birthweight and infant mortality. In considering low birthweight as an outcome, the key risk periods are both the preconception period (t1) and pregnancy (t2). These time periods largely determine the risk of neonatal mortality (death from 0-27 days). Events after birth (t3) contribute more towards post-neonatal (death from 28 days to <12months) mortality risk.

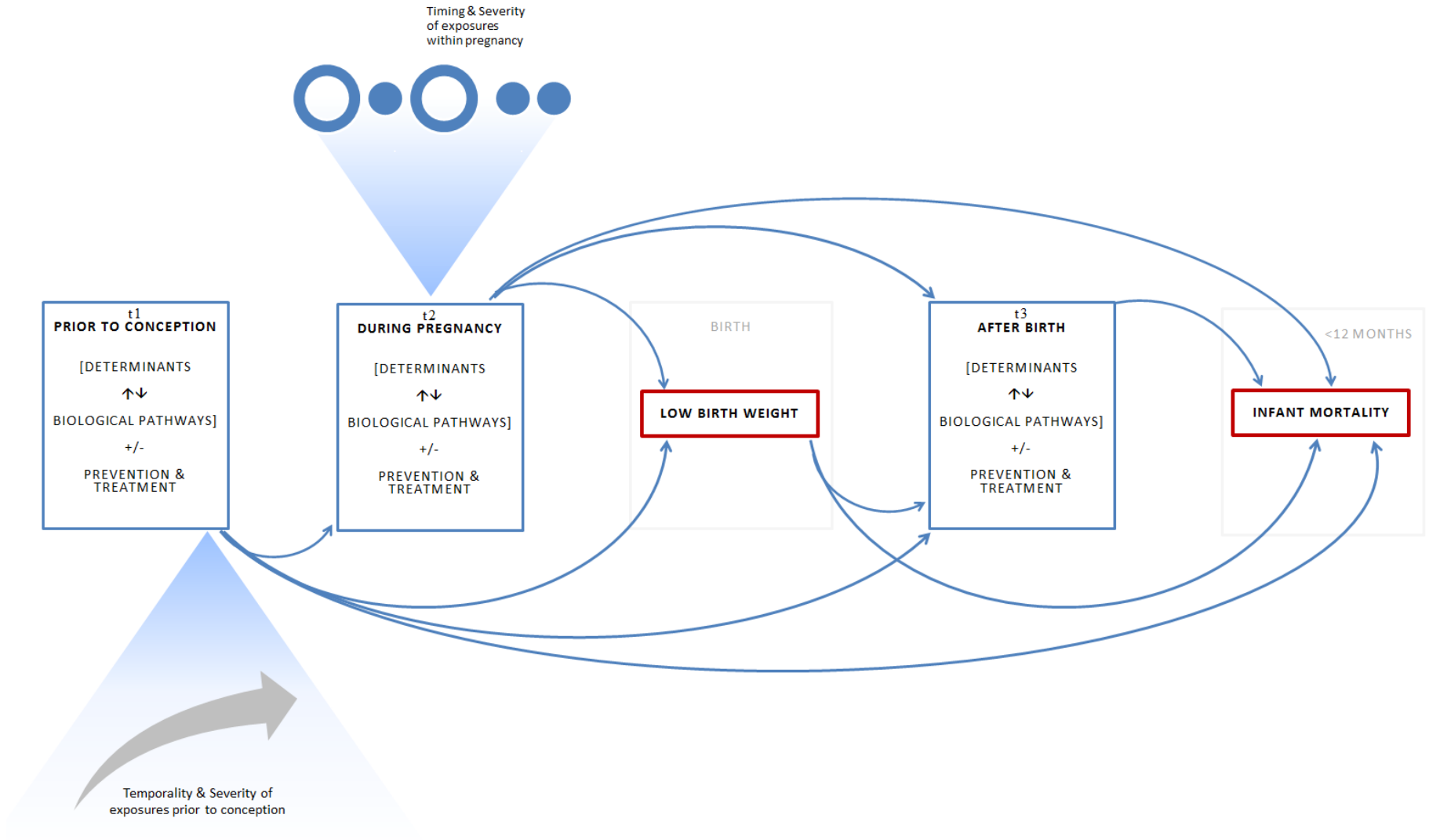


Figure 3.3 Timing of key events relevant to the risk of low birthweight and infant mortality risk

Context of time

The broader context of the time in which the mother lives and ultimately becomes pregnant is an important background factor to consider in the potential operation of factors within the conceptual framework. Historically, there has been a constant reduction in the rates of infant mortality over time. This is likely due to better antenatal health care through improved research, technology and education.[37] Broader societal changes over time may also impact infant mortality risk, for example, shifts in community attitudes or expectations of issues such as domestic violence.

3.5.2 Women prisoners and maternal imprisonment within the Conceptual Framework

This section explores how women in contact with the prison system may be considered within the revised conceptual framework for infant mortality. First, it highlights how characteristics common within the population of women with a history of imprisonment fit within the framework. Second, it considers the experience of imprisonment specifically in terms of how such an experience may operate through the framework and how the impact may be beneficial or harmful depending on the circumstances and timing of imprisonment.

How the characteristics of women prisoners may relate to infant mortality risk

Women prisoners, as a population, experience high rates of many of the determinants and biological risk factors relevant to infant mortality risk (Chapter 2). Table 3.1 presents a summary of the key characteristics and life experiences of women prisoners that may impact on their children's infant mortality risk through the conceptual model components.

Table 3.1 Characteristics of women prisoners that may impact on infant mortality risk (i.e. pre-existing disadvantage)

Framework components	Women prisoner characteristics
Broader determinants	
Community factors	Areas of high socio-economic disadvantage (increased policing, discrimination, etc.)
Household factors	Increased single parent households, insecure housing/homelessness, domestic violence, children in contact with child protection or in out-of-home care
Maternal factors	
Resources	Lower levels of education and employment
Trauma history	High levels of physical, sexual, emotional abuse in childhood and adulthood
Mental illness	High levels of mental illness including depression, anxiety, substance use disorders, psychoses, suicide, fetal alcohol syndrome, and TBI
Non-modifiable	Aboriginal women experience increased risks, harms and discrimination
Biological Pathways	
Maternal physical health	Increased rates of teenage pregnancy, higher fertility rates, reduced birth spacing, increased risk of chronic and communicable illnesses (e.g. BBVs and STIs)
Exposure to drugs and toxins	Increased smoking, alcohol and substance use disorders
Suboptimal nutrition	Poorer diet quality (?), (increased rates of obesity?)
Adversity (stress)	Experience greater number of adverse events over the lifecourse
Injury	Experience more violence and physical trauma
Prevention and Treatment	
Pregnancy related services	Less likely to access, more likely to delay commencement
Mental health services	Less likely to access
Drug and alcohol services	Less likely to access
General medical services	Less likely to access

How maternal imprisonment may impact on infant mortality risk

Table 3.2 considers how a mother's experience of imprisonment during each of the key periods (Figure 3.3) may impact on infant mortality risk through the components of the conceptual framework (Figure 3.2). As highlighted below, imprisonment is complex in nature and can potentially be beneficial or harmful depending on the context and specific circumstances of the mother, her sentence, and the prison environment.

Table 3.2 How maternal imprisonment may impact on infant mortality risk through the conceptual framework

Framework components	Potential effects of imprisonment on women/infants	Time	Impact
Maternal Factors			
Resources	Reduced financial resources, increased/maintained unemployment	t1-t3	Negative
	Reduced social/cultural supports during pregnancy	t2	Negative
Trauma history	Removal of women from domestic violence	t1-t3	Positive
	Imprisonment may retraumatise women (strip search)	t1-t3	Negative
Mental illness	Screening/treatment for mental illness	t1-t3	Positive
	Imprisonment may worsen mental illness	t1-t3	Negative
Non-modifiable	Social, cultural, emotional impacts Aboriginal women out of country	t1-t2	Negative
Biological Pathways			
Maternal physical health	Screening/treatment for acute and chronic illnesses	t1-t3	Positive
	Earlier onset and increased access to antenatal care	t2	Positive
	Risk of contracting communicable diseases (inc. BBV)	t1-t3	Negative
Exposure to drugs/toxins	Screening/treatment for substance use disorders	t1-t3	Positive
	Reduced consumption of alcohol and drugs in prison	t2	Positive
	Increased risk of overdose post-release	t2	Negative
Inadequate nutrition	Improved pre-conception maternal nutrition	t1	Positive
	Improved fetal nutrition	t2	Positive
	Reduced/cessation of breastfeeding (unless 'live-in')	t3	Negative
Adversity (stress)	Decreased maternal stress if home environment highly dysfunctional	t1-t3	Positive
	Decreased infantile stress if abusive mother removed from home	t3	Positive
	Increased maternal stress preconception	t1	Negative
	Increased maternal stress in pregnancy (impacts fetus)	t2	Negative
	Increased infantile stress from maternal separation	t3	Negative

3.6 Summary

We have updated the Mosley and Chen[1] framework to address the aims of this thesis specifically in relation to understanding the key factors that impact on infant mortality and low birth weight in a population of women prisoners. Creating an additional framework schematic (Figure 3.3) assists in conceptualising the potential contribution of risk factors at distinct periods.

One of the main questions within the literature of the outcomes of children of prisoners is whether infant mortality risk is accounted for by pre-existing maternal factors, or if prison has a direct impact. When applied to women prisoners, the revised conceptual framework highlights the importance of not considering maternal imprisonment exposure as a dichotomous variable, and considering the potential heterogeneity of the role of imprisonment as a risk (or protective) factor in pregnancy.

Although the revised conceptual framework has been specifically applied to maternal imprisonment in this thesis, this framework has potential application in the context of other services whose client base includes vulnerable women, mothers, and infants with multiple and complex disadvantages and intergenerational trauma histories. The framework is useful for broadly understanding the complexities of highly vulnerable populations experiencing multiple adversities.

3.7 References

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4 Project Methodology

4.1 Introduction

This chapter contains a description of the methods which underpin the research studies within the thesis. These methods relate to the overarching project design, including the sampling of the study populations, data sources and definition of key variables.

The thesis is comprised of five research studies which map against the research aims outlined in Chapter 1. An overview of the research studies is provided here, however, the specific methods relating to individual studies are described in their respective chapters.

4.2 Research design and approach

The research aims were addressed through a longitudinal retrospective cohort study using linked administrative data obtained through the Western Australian Data Linkage System (WADLS).

As there were no published data (other than small sample surveys) on children of women prisoners in Australia, the study proceeded through a two-staged approach. The initial study task was to determine the population statistics for children exposed to maternal imprisonment during childhood i.e. aged 0-17 years inclusive (Research Aim 1). The initial study population definitions and data specification reflected this aim and the current state of knowledge.

Preliminary investigations of the project data led to a refinement of the study aims (Research Aims 2-5). The high number of infant deaths amongst infants whose mothers had a record of imprisonment before the infant's birth, made the issue a priority for investigation and caused us to refine our definition of exposure to maternal imprisonment.

4.3 Western Australian Data Linkage System

The WADLS uses best-practice computerised probabilistic matching with clerical review to create a master linkage key between Western Australian administrative data collections. This enables the connection of records relating to an individual over a defined period of time and across multiple sources, including government registries (e.g. births, deaths, etc.) and services (e.g. hospitals, child protection services, corrective services, etc.). The linkage process is highly accurate, with 99.89% of links estimated as valid.[1]

Data linkage is a particularly useful tool for investigating sensitive outcomes in vulnerable populations. Participant privacy is maintained as there is no direct involvement required, such as with interviews or surveys in prospective longitudinal studies, and names and other personal identifiers are not released to researchers. Problems of loss to follow-up, recall and social desirability bias are also avoided. Research using linked data is also time and cost effective compared with de novo longitudinal studies.

Linkage between Western Australian corrective services data and other WADLS data collections has previously been performed for offender health research.[2-4]

4.4 Study populations

4.4.1 Definition of the cohort and comparison groups

The study population was comprised of two key groups; the cohort and a matched comparison group. The cohort was originally defined for the data request to include all liveborn children born in Western Australia from 1985 to 2011 who experienced their mother's imprisonment at least once during their childhood (Table 4.1). The data release for the cohort, however, included all children whose mother had at least one imprisonment record which fell within the eighteen-years of the child's date of birth, regardless of whether the child was still alive at the time of their mother's imprisonment. This was important in informing Research Aims 2-5.

The comparison group was originally defined to include only children whose mothers had no corrections record (including community-based corrections orders) in Western Australia (Table 4.1). There were, however, difficulties with sampling the comparison group according to that definition with the available data, and so through discussion

with the Data Linkage Branch the definition of the comparison group was revised to "children who were not cases", with the ability to later sub-divide groups based on mother's corrections history. The comparison group was matched to the cohort on year of birth, sex and Aboriginal status, and three comparison children were matched for each child in the cohort.

Table 4.1 Original and revised definitions of the cohort and comparison groups

Group	Definition
Cohort (original definition)	All liveborn children born in Western Australia between 1 January 1985 and 31 December 2011 who have experienced the incarceration of their biological mother in a Western Australian prison during their childhood (0-17 years inclusive).
Comparison (original definition)	A random sample of liveborn children born in Western Australia between 1 January 1985 and 31 December 2011 with a mother who has no record in any Department of Corrective Services dataset during the child's lifetime.
Cohort (data received)	All liveborn children born in Western Australia between 1 January 1985 and 31 December 2011 whose biological mother had at least one record of imprisonment in a Western Australian prison after the child's date of birth and before the date of the child's 18th-birthday **(regardless of whether the child was alive at the time of mother's first imprisonment after birth)**.
Comparison (revised definition)	A random sample of liveborn children **who are not cases** born in Western Australia between 1 January 1985 and 31 December 2011.

4.4.2 Total study population by maternal corrections history

In addition to the cohort and comparison groups, data were also obtained on the mothers of the cohort and comparison groups, siblings of cohort and comparison groups, and children born to the female members of the cohort and comparison groups (i.e. second-generation children).

The revised definition of the comparison group meant children could be included in the comparison group whose mothers had records of imprisonment before the child's date of birth or after the date of their 18th-birthday. This led to instances of siblings being in both the cohort and comparison groups. The comparison group also contained children whose mothers had community-based corrections orders (and no record of imprisonment) at any time.

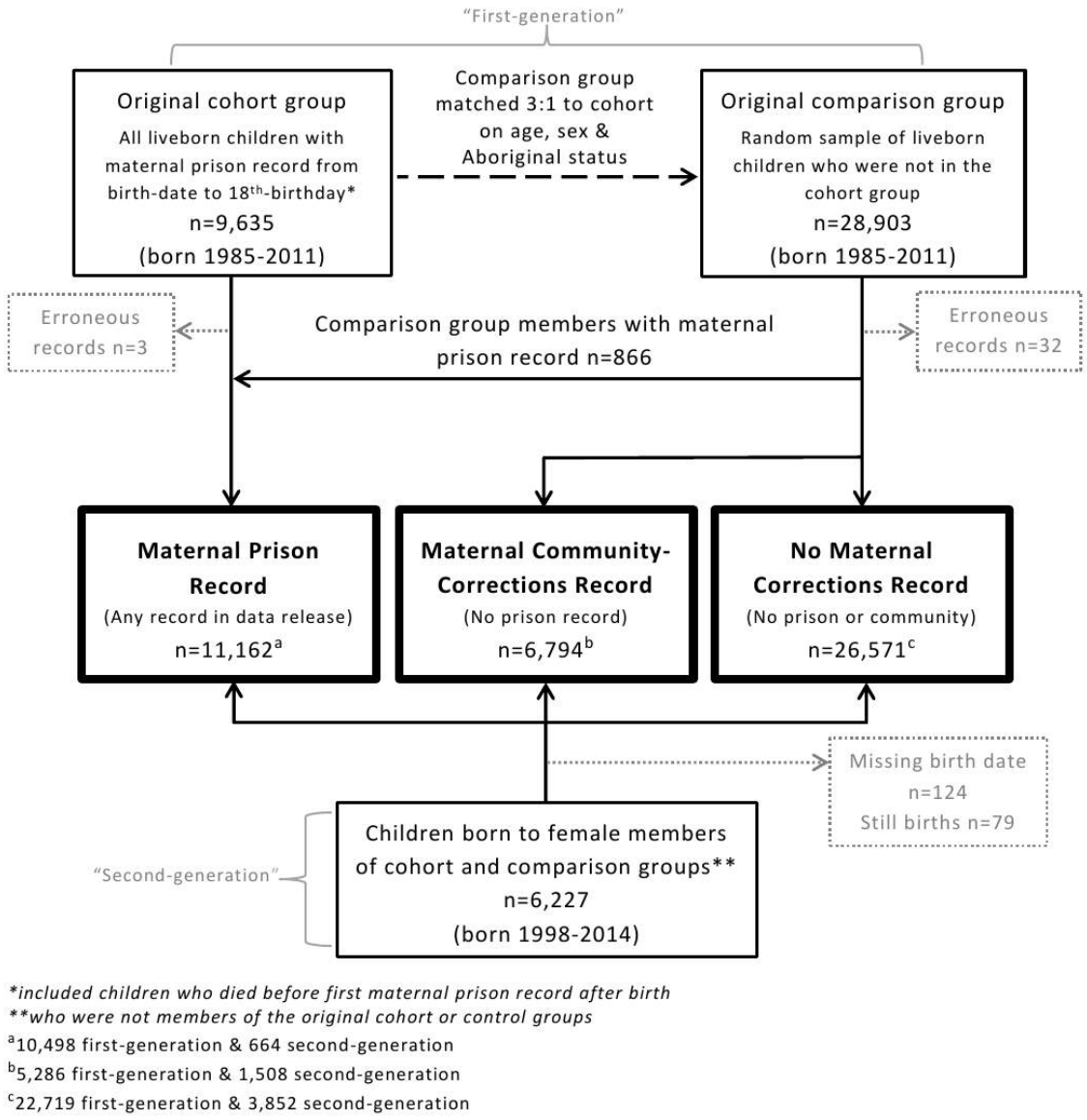
There are substantial differences between women with a history of imprisonment or criminal justice involvement and women in the general community, as highlighted in the review of the literature in Chapter 2. Accordingly, the study population was reclassified based mother's corrections history into three mutually exclusive groups according to mothers having a record of imprisonment, community-corrections order, or no corrections order at any time during the data observation period (<1980-2015), as shown in Figure 4.1.

Studies III-V also drew on the additional data obtained for the 'second-generation' children who were born to the female members of the cohort or comparison groups (i.e. the 'first-generation') and who were not also members of the cohort or comparison groups themselves (n=1,083).

Siblings of the cohort and comparison groups (who were not also members of those groups), were not included in the total study population for analyses. Birth year was the only data item obtained for siblings, for the purpose of determining family size and birth order of the cohort and comparison children (Figure 4.1).

Erroneous records, such as records with multiple mothers or missing key information such as birthdate were removed (Figure 4.1). All children in the first-generation (cohort and comparison) were liveborn, and so stillbirths were removed from the second-generation (Figure 4.1).

The total study population, as shown in Figure 4.1, comprised 44,765 individual children across the first- and second-generations. There were 11,162 children (n=10,498 first-generation, n=664 second-generation) whose mothers had a prison record (at any time); 6,794 children (n=5,286 first-generation, n=1,508 second-generation) whose mothers had a community-corrections order (without a record of imprisonment); and 26,571 children (n=22,719 first-generation, n=3,852 second-generation) whose mothers had no corrections record at any time.



*included children who died before first maternal prison record after birth
**who were not members of the original cohort or control groups
[a]10,498 first-generation & 664 second-generation
[b]5,286 first-generation & 1,508 second-generation
[c]22,719 first-generation & 3,852 second-generation

Figure 4.1 Total study population, by maternal corrections history

The specific samples used for the individual research studies are described in the following sections.

4.5 Overview of research studies and exposure groups

Five research studies were conducted to address the research aims outlined in Chapter 1, as summarised in Table 4.2. Studies I and II addressed the descriptive aims of the research by determining the prevalence and characteristics of exposure of Western Australian children (Study I) and infants (Study II) to maternal imprisonment.

Table 4.2 Overview of research studies I-V

	Study I	Study II	Study III	Study IV	Study V
Thesis aims	Aim 1	Aims 1 & 2	Aims 2 & 3	Aims 2 & 4	Aim 5
Brief description	Prevalence and descriptive study of children (0-17yrs) affected by maternal imprisonment	Prevalence and descriptive study of infants (0-1yrs) affected by maternal imprisonment	Determinants of infant mortality and maternal corrections history	Determinants of low birth weight and maternal corrections history	Characteristics of maternal imprisonment in pregnancy and risk of low birth weight and infant mortality
Study design	Descriptive	Descriptive	Analytical	Analytical	Analytical
Main study components	Prevalence Descriptive characteristics	Prevalence Descriptive characteristics Child protection contact Infant mortality rates	Maternal corrections history and risk of infant mortality Risk factor prevalence by maternal corrections history	Maternal corrections history and risk of low birth weight Risk factor prevalence by maternal corrections history	Characteristics of maternal corrections contact and risk of low birth weight and infant mortality
Exposure to maternal imprisonment	*Birth to age<18yrs	*Birth to age<2yrs (exposure description) Pregnancy to age<2yrs (child protection) Five-years before birth to age<1yr (infant mortality)	During pregnancy Before, but not during, pregnancy First record after birth	During pregnancy Before, but not during, pregnancy First record after birth	During pregnancy
Other exposure groups	None	No maternal corrections	Maternal community-based corrections No maternal corrections	Maternal community-based corrections No maternal corrections	None
Generation	First-generation	First-generation	First- & second-generations	First- & second-generations	First- & second-generations
Birth years	Jan-1985 to Dec-2011	Jan-2001 to Dec-2011 Jan-1992 to Dec-2011 (infant mortality)	Jan-1985 to Jun-2013	Jan-1985 to Jun-2014	Jan-1985 to Jun-2013 (infant mortality) Jan-1985 to Jun-2014 (low birth weight)
Exclusions	None	None	Chromosomal abnormalities Stillbirths (second-gen.)	Chromosomal abnormalities Stillbirths (second-gen.) Multiple gestation pregnancies	Chromosomal abnormalities Stillbirths (second-gen.) Multiple gestation pregnancies (LBW only)

***Comprises entire WA population exposed to maternal imprisonment within specified age range. Note: See Appendix D for chromosomal abnormalities ICD-codes.**

Studies I and II were focussed primarily on children exposed to maternal imprisonment after birth and accordingly their study populations were sampled from the first-generation only. The population in Study I comprised the entire population of Western Australian children who were exposed to maternal imprisonment at least once during their childhood, from birth to their 18th-birthday.

Study II utilised different study subgroup observations to address the specific study aims. For the prevalence and descriptive components of Study II, the study population comprised the entire population of Western Australian infants exposed to maternal imprisonment at least once after birth and before their second-birthday. For the child protection analyses, this population was extended to also include infants whose mothers were imprisoned during pregnancy as it is possible for infants to have child protection matters commenced during their pregnancy. Infant mortality rates were calculated for infants whose mothers had a history of imprisonment up to five-years prior to their birth or during their first year of life.

Studies III to V were analytical studies focussed on the infant mortality and low birth weight outcomes for children with different maternal corrections exposure. Studies III and VI compared outcomes for infants born to mothers who were imprisoned during pregnancy to children whose mothers were imprisoned at times other than pregnancy. For these comparison groups we separated children whose mothers were imprisoned before pregnancy from those whose mothers were first imprisoned after their birth. Two other comparison groups consisted of children whose mothers had a community-corrections record at any time, and children whose mothers had no corrections record at any time. These exposure groups were mutually exclusive as indicated in Figure 4.2.

Study V focussed solely on infants whose mothers had a record of imprisonment during their pregnancy, to allow for the detailed investigation of characteristics of maternal corrections contact during pregnancy and their relationship to low birth weight and infant mortality outcomes.

The study populations used in Studies III to V were extended to include the second-generation children to maximise the observations of infant mortality and imprisonment during pregnancy. The implications of this are considered in the next section.

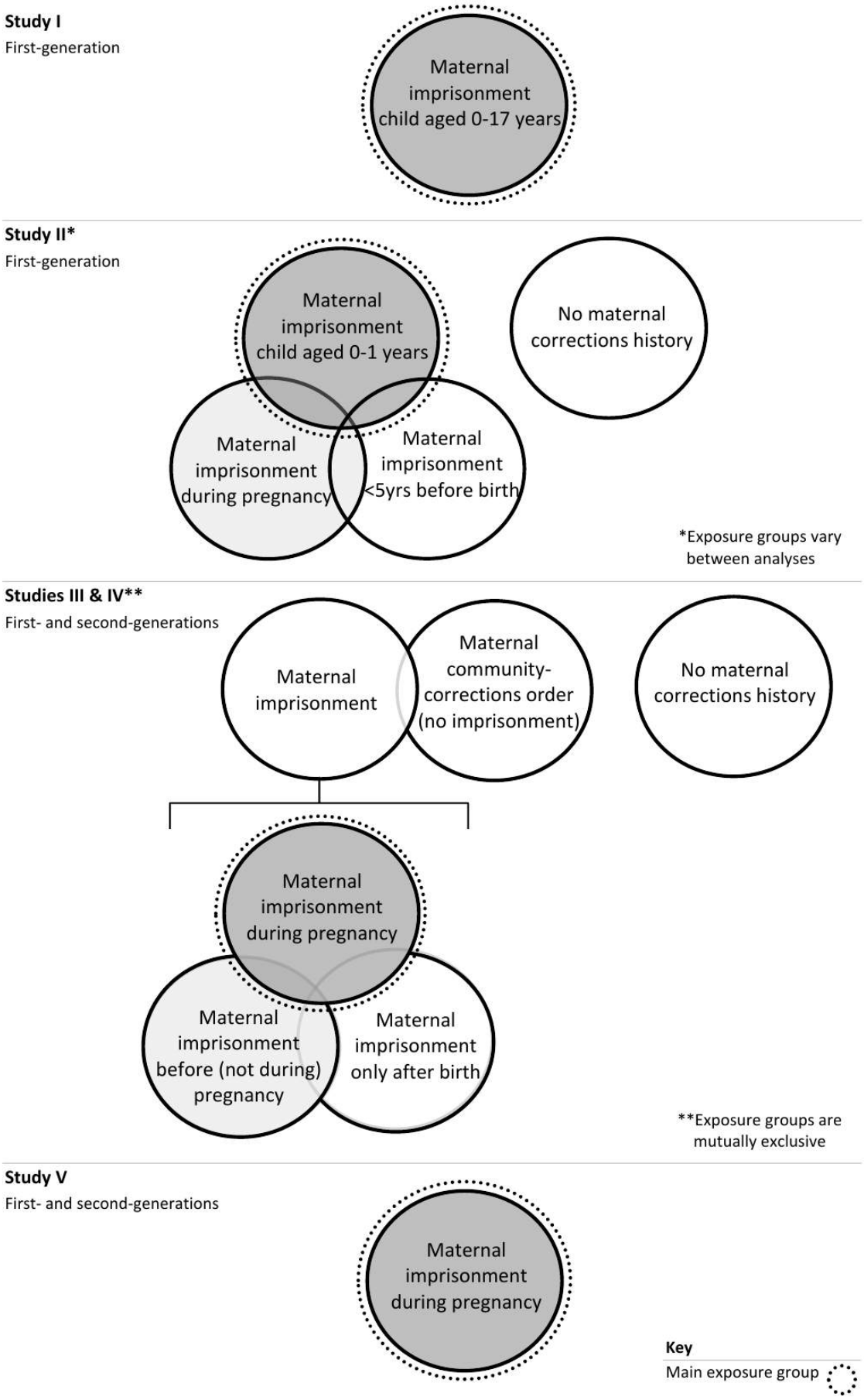


Figure 4.2 Maternal corrections exposure sub-groups for Studies I-V

4.5.1 Sampling of study populations for Studies III-V

The sampling of the children with maternal prison records across the first- and second-generations is summarised in Figure 4.3. Each circle represents a time period in relation to pregnancy (before conception, during pregnancy, and after birth) in which a child's mother may be imprisoned. The overlap signifies that mothers may have multiple or extended records of imprisonment that mean children can fall in multiple sub-categories.

The bold circle encompassing maternal 'prison record after birth' indicates the study sample included all eligible children born in Western Australia between 1985-2011. For some of these children their mothers will also have had a record of imprisonment before conception and/or during pregnancy. Also captured in this sample were all second-generation children born from January 2012, whose mothers were imprisoned after their birth.

Children whose mothers only had records of imprisonment prior to their birth, were drawn from the random sample of Western Australian children obtained for the comparison group in the first-generation, and included all of the second-generation children born to the cohort and comparison group members who had mothers imprisoned before their birth.

Accordingly, although the study population for the initial data extraction was not defined to include all infants whose mothers were imprisoned before conception or during pregnancy, there is no reason to expect the sample is biased. That is, the children sampled within these groups from the first- and second-generations should be representative of Western Australian children with these sub-classifications of exposure.

Likewise, in developing a cohort of children whose mothers had a history of community-corrections records (at any time in relation to pregnancy and childhood) or no corrections record, there is no reason to expect the study sample will be biased. It is expected these groups should be representative of Western Australian children within these categories of exposure. This is because these groups were also drawn from a random sample of the Western Australian population (if sampled in the first-generation) or included all the children born to the cohort and comparison groups within these categories of maternal corrections exposure.

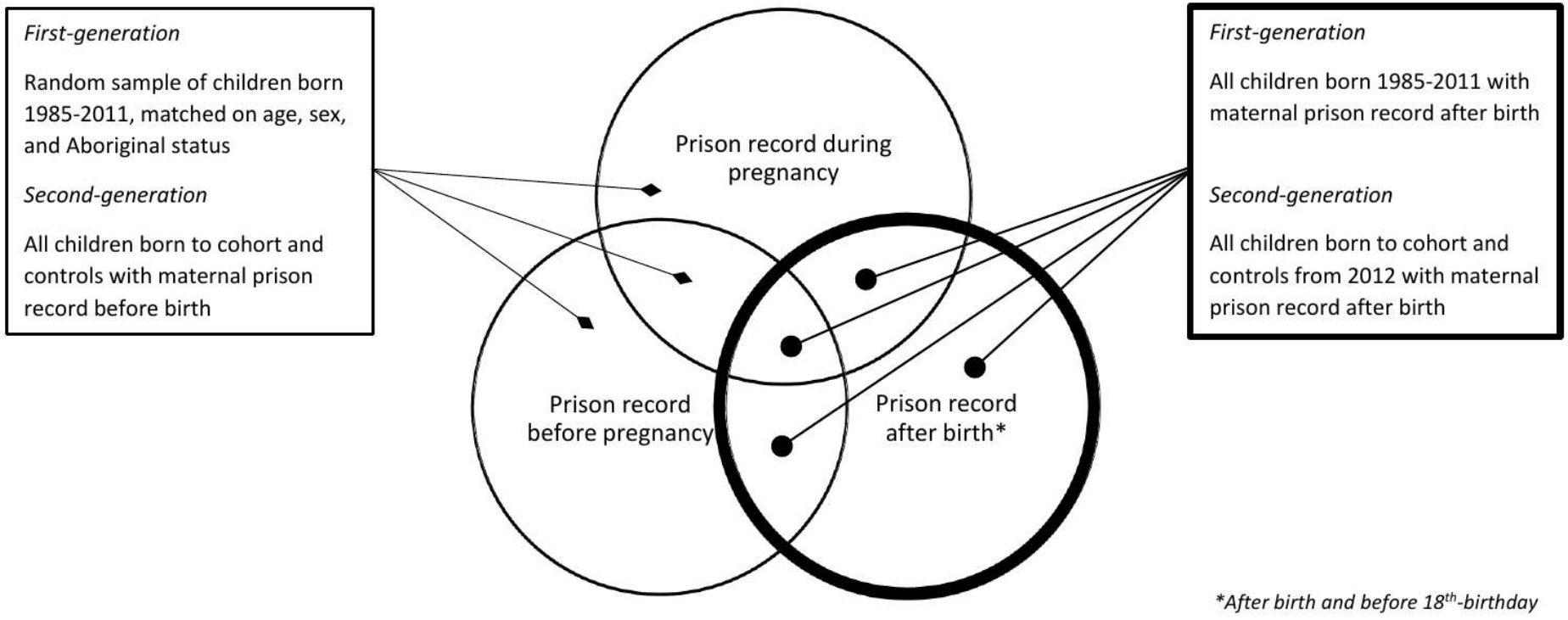


Figure 4.3 Maternal prison exposure sub-groups for Studies III-V

Due to the higher prevalence of Aboriginal imprisonment, the 3:1 matching of comparison children to cohort children on Aboriginal status, the higher fertility of Aboriginal mothers relative to non-Aboriginal women, and the comparatively smaller Aboriginal population in overall number, we sampled more Aboriginal children with maternal prison records before birth than for the non-Aboriginal population. However, there is no reason to expect the sample is biased or unrepresentative for the reasons stated above.

With respect to the second-generation children born to the female members of the cohort and comparison groups, although it is likely that women who were exposed to maternal imprisonment in childhood will have given birth to more children at younger ages and had prison contact themselves, all analyses within Studies III to V have taken these related demographic and pregnancy-related risk factors into account. For example, maternal age, parity, birth spacing, socio-economic disadvantage, and maternal corrections history, were accounted for and all analyses were stratified by infants' Aboriginal status.

The sources and preparation of the data for the studies are outlined in the following sections.

4.6 Data sources

Table 4.3 outlines the data collections utilised for the project. These are all statutory State-wide data collections with good coverage of the Western Australian population.

Data on birth registrations, death registrations, midwives records, and child protection system contacts were obtained for all first-and second-generation children. Additionally, for all first-generation cohort and comparison children, data on hospital, mental health and corrections services contacts were obtained. Corrections, hospital, mental health and death data were obtained for all mothers of the first- and second-generation children.

Emergency department data was released for all individuals but was only available for records from 2002. For this reason, Emergency Department data was not used for risk factor measurement, however, Emergency Department data was used to supplement missing demographic data. All other data sources were available for the entire observation period for the relevant study population subgroups.

Table 4.3 Brief description of data sources

Data collection	Description of data collection
Midwives Notifications System (MNS)	Notifications for all births attended by a midwife where the gestational age is at least 20 weeks or infant weight 400g+ if gestation unknown
Birth Registrations	All births registered in Western Australia
Death Registrations	All deaths registered in Western Australia
Department of Justice Department of Corrective Services	All records of adult and juvenile offenders detained in Western Australian prisons, and under departmental supervision on community-based orders Excludes immigration detention and mental health facilities On 1 July 2017, the Department of Corrective Services and the Department of the Attorney General amalgamated to become the Department of Justice The two department names should be read interchangeably throughout this thesis
Hospital Morbidity Data Collection (HMDC)	All inpatient separation records for Western Australian public and private acute and psychiatric hospitals
Mental Health Information System (MHIS)	All presentations to public community mental health services
Department of Communities: Child Protection and Family Support	All reports of concern for child welfare, child protection investigations, child protection applications and orders, and placements in out-of-home care
Emergency Department	All episodes of care in emergency departments in Western Australian public hospitals and private hospitals under contract with the Western Australian government.

4.7 Data preparation

Each dataset was cleaned and cross-checked before the analyses were conducted to ensure intra- and inter-dataset consistency. Cleaning processes included checking for duplicate records, inconsistent or implausible records, for example ensuring record start-dates preceded end-dates, and individuals were alive and of a plausible age at time of event records. Variables were transformed to enable analysis and ensure consistency across datasets, for example string date variables were recoded in consistent numeric formats, and text variables were recoded as numeric categorical variables. Key variables were checked for missingness.

The following sections contain a description of how the key variables used throughout the research studies were determined from the project data obtained through the WADLS.

4.7.1 Demographic variables

Child sex and birth date

Child birth date (to month and year of birth) and sex were extracted from the Birth Registration data, or the Midwives Notification System data if Birth Registration data were unavailable.

Mother birth date

As Birth Registration and Midwives Notification System data were not obtained for mothers of the first-generation children, mother birth date was determined using all available data. The process of determination was made on an assessment of the best available data and validation against other data sources as outlined in Appendix B.

Aboriginal status

Aboriginal status for children and mothers in the study populations was provided through the Derived Indigenous Status Flag variable generated by the WADLS using best-practice algorithms, which assess individuals' Aboriginal status across multiple data collections to enhance accuracy.[5] Aboriginal status between mother and child were checked against the approach taken in Christensen et al[5] and amended if necessary. That is, if a mother was flagged as 'Indigenous', but her child or children were not, then children's records were altered to 'Indigenous'. If a child was flagged as 'Indigenous', but their mother was not, this was not altered as in the absence of mother's own 'Indigenous' flag it was assumed her child's Indigenous status was inherited through their father.

Socioeconomic status and geographical remoteness at birth

The Socio-economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage (IRSD)[6] and the Accessibility/Remoteness Index of Australia (ARIA)[7] were used to describe infant's socioeconomic status and the geographical remoteness of their place of residence at time of birth.

The SEIFA IRSD summarises a range of socioeconomic conditions of residents and households within a geographical area to develop a measure of the relative disadvantage of that area. The information used to develop the index is obtained through the Australian census. Variables indicating disadvantage included in the development of the IRSD include factors such as low educational attainment, low skill occupations,

unemployment, overcrowding, family breakdown, single parent households, low income, children with jobless parents, and disability.[8] A low index score indicates higher observation of these factors in households within an area, and overall greater disadvantage. A high index score indicates relatively less disadvantage is experienced by households in the area.

The ARIA is derived from the accessibility between place of residence and populated locations and key services and classified by five categories of major cities, inner regional, outer regional, remote, and very remote locations.

SEIFA scores and ARIA data were provided primarily through the Midwives Notification System, however, data were also provided in the Emergency Department data. The data obtained for the project included SEIFA and ARIA scores for three censuses (1996, 2001, and 2006) for each individual record.

In determining SEIFA and ARIA, the aim is to use the smallest regional designation possible that contains fewest households for greater accuracy. The smallest area of reporting is the Collection District (CD) level, which is about 250 households or less in rural areas.[9] CD level data is not available for certain areas, for example where low census response rates would jeopardise the representativeness of respondents.[10] Other examples for exclusion include very low levels of employment or where income could not be calculated in 70% or more households.[10] Missingness of CD level data for an area is therefore likely to be associated with disadvantage. Missingness can also be due to insufficient address information being provided at the point of service contact, for multiple reasons such as a client unable or unwilling to provide an address, being homeless, or providing incorrect information.

The best available source of SEIFA data was CD level data provided through the Midwives dataset for the census closest to the infant's birthdate. Within the study population, there was a high proportion of children missing CD level data from the Midwives Notification System for the census closest to their birth date. For instance, for 15.8% of the first-generation cohort children were missing best available SEIFA data. Missingness was higher for Aboriginal infants, with 18.6% of Aboriginal first-generation cohort children missing best available SEIFA data compared to 11.2% of non-Aboriginal children within the same cohort. This was similar in the first-generation comparison group children, with 18.4% of Aboriginal children and 9.6% of non-

Aboriginal children missing the best-available CD level data for the census closest to their birth date from the midwives data.

For this reason we developed a process of SEIFA determination (Appendix C, Table C1) that also utilised the CD level data available from the Emergency Department (ED) dataset, for those missing best available SEIFA data. In the first instance the ED data was limited to the first ED record for an individual after birth but only where the postcode stated on the ED record matched the postcode stated on the midwives record at time of birth. For the first-generation cohort this provided SEIFA data for nearly one-third of those missing best available CD level data from the midwives dataset. The SEIFA distributions for individuals allocated using the CD level data (from the census closest to child's birthdate) from the ED and Midwives data, compared well as illustrated in Appendix C (Appendix C, Figure C1).

The process of SEIFA determination used in the thesis is described in detail in Appendix C (Table C1). The approach favoured the use of any available CD level data (even for the second or third closest census to the child's birthdate), to the use of higher level area data for Statistical Local Areas (SLA) or Local Government Areas (LGA) which is common practice (Calver et al 2007). For instance, the method developed in the thesis replaced missing CD scores for individuals with the mean CD score by postcode which was calculated from the all individuals with available CD level data for the same postcode (and for the same census years) stratified by Aboriginal status, before using SLA or LGA data.

A comparison between the method developed and applied in the research studies contained in the thesis and alternative methods (Appendix C, Table C2) is provided in Appendix C (Figure C2), using the first-generation cohort as an example.

A similar process was taken in the determination of ARIA for the study populations (Appendix C, Table C3). Further support for the method of determination developed by using the available CD level data from the ED dataset, was found on investigation of the ARIA data that found that one-quarter of CD level ARIA determinations (e.g. 'inner regional') that matched across the three censuses (1996, 2001, 2006), were different to the SLA-level ARIA determinations (e.g. 'outer regional'), which also matched across the three censuses. This indicated the large differences between using CD and SLA for ARIA.

4.7.2 Child protection contact

For Study II child protection system contact was defined as any record within the Western Australian Department of Communities: Child Protection and Family Support database, covering reports made to the Department concerning a child's welfare, applications or orders for a child's protection, and placements in of out-of-home care. Out-of-home care placement is not always a response to a child abuse or neglect substantiation but can also be to provide short-term respite for parents or other caregivers.

4.7.3 Definition of infant mortality

The accepted definition of infant mortality is the death of a live born child under one year of age.[11] All children sampled within the first-generation were liveborn, and stillbirths were removed from the second-generation study population. Full date of death (DD/MM/YYYY) was provided in the death registration data, however, birth data were provided to month and year of birth (MM/YYYY). Accordingly, infant mortality was defined as death within 12-full months after birth. For example, as illustrated in Figure 4.4, for a child born in January 2000, death on or before 31 January 2001 would be determined as an infant mortality case.

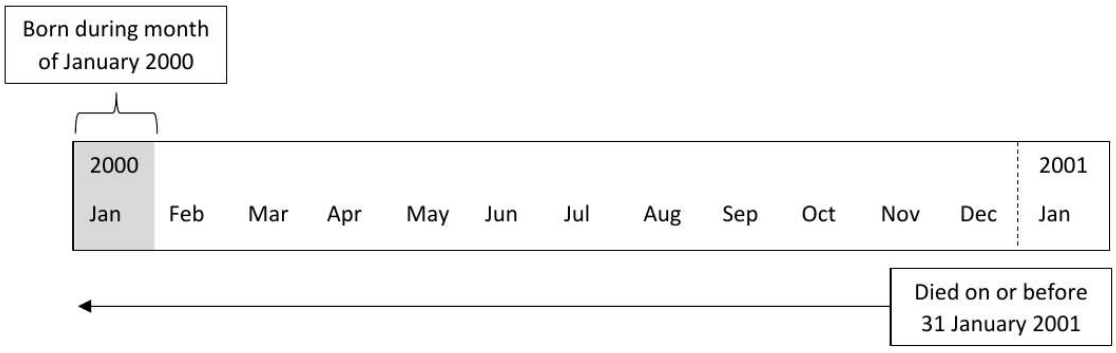


Figure 4.4 Illustrative example of definition of infant mortality

4.7.4 Maternal corrections variables

In Studies III and IV, the only maternal corrections factors analysed were the broad exposure categories of maternal imprisonment before, during or after pregnancy, or maternal community-corrections orders alone, as described above.

Characteristics of maternal imprisonment were derived from the Department of Corrections data and described and analysed in Studies I, II and V. Characteristics included length and number of imprisonments, sentence type, and offence type.

Major offence type is recorded in the Department of Justice data collections using the Australian and New Zealand Standard Offence Classification, which contains 16 Divisions classified according to the offence aim, use of violence, victim, seriousness and intent.[12]

In Study I, offence type was described in full by all 16 Divisions. In Studies II and V, offence type were described in six categories: Offences against the person (Divisions 1–5); Theft and related (Divisions 6–8); Fraud and related (Division 9 and bribery offences); Drug (Division 10 and licit drug offences); Public order (Divisions 11–13 and 16); Traffic and related (Division 14, and driving under the influence of alcohol or other substance, dangerous or negligent driving offences); and Breach of justice procedures (Division 15).

4.7.5 Pregnancy exposure definition

As gestational age at birth was not obtained, and child birth date was provided to month only, pregnancy start date was calculated as being nine months before the first day of the child's birth-month. For example, as illustrated in Figure 4.5, for a child born in the month of January 2000, pregnancy start date was determined as being 1 April 1999. All events that occurred within this period (e.g. 1 April 1999 to 31 January 2000) were considered as exposures within pregnancy. For 'events' or exposures that could occur over a period of time (e.g. period of imprisonment, child protection order, etc.), any (including partial) occurrence during the defined pregnancy period was classified as an exposure during pregnancy, as represented in Figure 4.5.

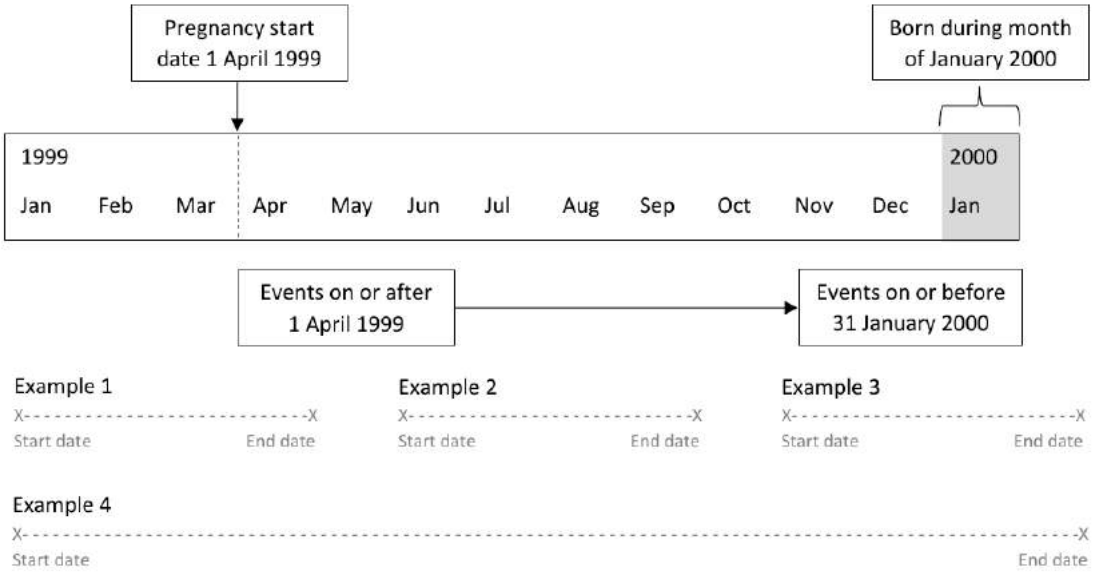


Figure 4.5 Illustrative example of definition of 'pregnancy'

4.7.6 Pregnancy-related risk factors and complications

Studies III-V measured, and adjusted for, key pregnancy-related risk factors and complications. These were informed by the Conceptual Framework outlined in Chapter 3. These drew on demographic variables including child and maternal birth dates, Aboriginal status, socioeconomic status, and remoteness, as described above, as well as additional data from other data collections including the Hospital Morbidity Data Collection (HMDC), the Mental Health Information (MHIS) data collections.

The HMDC and MHIS data collections use the International Statistical Classification of Diseases (ICD)[13] (ICD-9-CM[14] to June 1999, ICD-10-AM[15] from July 1999), to classify diagnosis, or reason for health service contact. For hospital records, the principal diagnosis code and up to four codes for external causes of injury, were obtained.

In accordance with the Conceptual Framework (Chapter 3), factors were classified into four main groups; demographic characteristics (described above under 'Demographic variables'), baseline pregnancy risk factors, pregnancy complications, and other maternal risk factors and exposures, as described below.

Baseline pregnancy risk factors

Maternal age was calculated as the age of mother at time of birth of the subject child. Parity and duration of birth spacing were determined using data on birthdates of all

siblings. Multiple gestation pregnancies were derived based on siblings having shared birth dates or through maternal or child HMDC data (see Appendix C, Table C2 for ICD codes). Child-level HMDC data were not obtained for the second-generation children, however, as stillbirths were captured for the second-generation (and all siblings) this assisted in identifying multiple gestation pregnancies.

Pregnancy complications

The pregnancy complications measured and investigated were informed by Salihu et al.[16] A full list of the complications considered and related ICD codes is provided in Appendix C (Table C3). Note, that Salihu et al[16] identified maternal history of a prior infant mortality, as a risk factor for having an infant born small for gestational age in a subsequent pregnancy. This risk factor was not able to be included within the present study due to insufficient data for siblings. More siblings were included within the first-generation cohort than the comparison group, which would bias the observations of infant mortality for siblings of the cohort. The other variables related to maternal history or using sibling data were not biased, as parity was calculated using sibling birth year (available for all infants), and maternal history of abortion or similar conditions were determined using mothers' hospital data (available for all mothers).

Other maternal risk factors and exposures

Maternal substance use (including alcohol) and poisoning-related service contacts during pregnancy were identified from HMDC and MHIS data (Appendix C, Table C4). Maternal hospital admissions for any injuries from external causes, excluding substance use, self-harm and poisoning related service contacts were identified during pregnancy (Appendix C, Table C5). Maternal hospitalisations for mental and behavioural disorders, self-harm, and mental health service presentations, both excluding substance use and poisoning-related service contacts, were identified from HMDC and MHIS data (Appendix C, Table C6). Infant having an older sibling in contact with the Child Protection system during an infant's pregnancy was included as a measure of maternal vulnerability and household dysfunction.

4.8 Ethical considerations and approvals

Ethics approvals were obtained from the Department of Health Human Research Ethics Committee, the Western Australian Aboriginal Health Ethics Committee (WAAHEC), and the University of South Australia Human Research Ethics Committee.

In obtaining support for the project, we consulted with members of the Western Australian Aboriginal community, as well as members of Seeds of Affinity in South Australia who are an organisation supporting women with lived prison experience and their children (see Appendix K for their letters of support).

Each of the studies within the thesis that have been published (Studies I-III) or are under review (Study IV) have been provided to the project partners, including WAAHEC, for review prior to public dissemination. Explicit approval has been received by the Department of Justice for all research outputs.

4.9 References

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5 Study I
Prevalence Study of Western Australian Children of Women Prisoners

The following study addresses Research Aim 1 by determining the prevalence and characteristics of exposure of children aged 0-17 years (inclusive) to maternal imprisonment in Western Australia.

The work contained within this chapter has been peer-reviewed and published. The citation for the published study is:

> Dowell, CM, Preen, DB & Segal, LS 2017, 'Quantifying maternal incarceration: a whole-population linked data study of Western Australian children born 1985-2011', *Australian and New Zealand Journal of Public Health*, vol. 41, no. 2, pp. 151-7.

The published version of the manuscript is presented in Appendix I.

Within the following chapter, the use of term 'Indigenous' in the manuscript version has been changed to 'Aboriginal' for consistency within the thesis.

In the published manuscript (Appendix I), the characteristics of children in the entire study cohort are reported (i.e. born 1985-2011). In the following chapter, however, this analysis has been altered so as to describe the characteristics of children in the cohort with 18-years of maternal imprisonment exposure data available (i.e. born 1985-1996), so that the descriptive data, such as age at first exposure, are representative of the population.

5.1 Abstract

Rationale

There are currently no routinely reported population-level statistics available on the children of women prisoners in Australia. Baseline information of the number and characteristics of children who experience maternal incarceration is needed to help establish their service needs and inform the development of criminal justice policies.

Objective

To measure the prevalence of children affected by maternal incarceration in Western Australia (WA).

Methods

Using linked administrative data we identified all children born in WA between 1985 and 2011, whose biological mother was imprisoned during their childhood. Data was obtained through the WA Data Linkage Branch from the Department of Corrective Services, Midwives Notifications System and Birth Registrations data collections. Descriptive characteristics of the children and their mothers are reported. Prevalence was measured in two-ways, the proportion of children ever affected in childhood and affected annually.

Results

Childhood prevalence of maternal incarceration was 26-times higher (95%CI 23.9–28.2) for Aboriginal children born 1992–1996 with 18.8% Aboriginal children and 0.7% non-Aboriginal children affected while aged 0–17 years. On average 1,544 children were affected each year across 2003–2011, at rates of 2,929 per 100,000 Aboriginal children and 108 per 100,000 non-Aboriginal children.

Conclusions

The findings present the first census of children affected by maternal incarceration within an Australian State and identify a large disparity between Aboriginal and non-Aboriginal populations. This study highlights the importance of formal consideration of children of women prisoners in the development of criminal justice policies and practices.

5.2 Background

Children of incarcerated parents are a uniquely vulnerable group. Exposed to a range of disadvantage within their family environment in such forms as domestic violence, parental mental health and substance use issues,[1, 2] they face additional difficulties through parental incarceration with disruption of care arrangements,[3, 4] financial impacts,[5] stigmatisation,[6] and psychological distress.[7, 8]

While debate exists over whether parental incarceration has any causal effect on child outcomes, over-and-above the effect of family environments,[9, 10] the literature has consistently found children of prisoners experience a range of problems. These issues include internalising and externalising behaviour problems,[11] poor developmental outcomes,[12] academic difficulties, lower rates of school completion,[13] delinquency,[14, 15] and child mortality.[16]

Regardless of causality, children of prisoners are a vulnerable population with complex needs that warrant tailored attention. However, children of prisoners have received little attention from government. They are not the core business of any one department and instead intersect with numerous services including child protection, health, education and corrections. Currently services for Australian children of prisoners are provided on an ad hoc basis and vary considerably between States, Territories and prisons.[17]

This population is particularly invisible in their absence from any official statistical reporting.[18] A small number of estimates of the proportion of prisoners who are parents exist from prisoner survey data,[2, 19] and few studies have estimated the extent of children affected from prisoner surveys based on a range of assumptions.[18, 20]

Without a clear picture of the number of children experiencing parental incarceration and a description of their basic characteristics, it is impossible to deliver appropriate services or to consider their needs in the development of criminal justice policies.

Children of incarcerated mothers face a unique set of circumstances in addition to those relating to paternal incarceration. Incarcerated mothers are more likely to have been the primary or sole child-caregiver prior to imprisonment.[21] For young children this may contribute to disruption of secure attachment if mother-baby facilities are not available in correctional facilities.[12] Although the absolute numbers of women prisoners are low compared to men, the female prison population is growing at a faster rate.[22]

Aboriginal women are the fastest growing prison population within Australia.[23] Many Aboriginal Australians experience worse health and social outcomes than non-Aboriginal Australians, resulting from a long-history of systemic discrimination including land dispossession and the forced separation of Aboriginal children from their families.[24] The imprisonment of Aboriginal mothers is a particularly important issue given the propensity for this to continue disruption of Aboriginal families and culture for future generations.

In this context, the objective of the current study was to describe the size and extent of the Western Australian (WA) population affected by the incarceration of their mother during childhood, with a particular focus on differences between Aboriginal and non-Aboriginal populations.

5.3 Methods

5.3.1 Cohort selection

The cohort included all children born in WA between 1 January 1985 and 31 December 2011 whose biological mother had at least one custodial record in a WA prison during their childhood (0–17 years inclusive) to 31 December 2014. This included mothers who were unsentenced remandees or juveniles held in custody.

A custodial record was defined by any entry in the WA Total Offender Management Solution (TOMS) system. The TOMS system is maintained by the WA Department of Corrective Services (DCS) and includes all custodial records within WA. It excludes unsentenced individuals detained in holding cells within police stations and courts, immigration detention centres, and mental health facilities. Mothers with community corrections orders but no custodial record were excluded from the study population.

5.3.2 Data linkage and extraction

The identification of the study population and extraction of links for project data were performed by the WA Data Linkage Branch. The Data Linkage Branch maintains the Western Australian Data Linkage System (WADLS). The WADLS uses computerised probabilistic matching with clerical review to establish a master linkage key between WA administrative data collections.[25] The linkage process is highly accurate, with 99.89% of links estimated as valid.[25] Linkage between DCS and other WADLS data

collections has previously been performed for offender health research.[26-28] Aboriginal status for mothers and children was provided through the WADLS using best-practice algorithms,[29] which derive Aboriginal status across multiple data collections to reduce missing data and improve consistency.

Children's records were extracted from the Birth Registrations and Midwives Notification System data collections. Data were available from both sources for the period of January 1985 to December 2011. Data on mothers were extracted from the DCS data collection and restricted to prison records on or before 31 December 2014. Erroneous records in which the prison reception and discharge date-time were identical (n=67) were excluded. For prison records not discharged by the date of data extraction (28 August 2015, n=68), a censoring date of 28 August 2015 was assigned for the calculation of child age and length of imprisonment.

5.3.3 Study subgroup observations within the total cohort

As the cohort was born between 1985-2011, data were available for various lengths of time for individual cohort members. Accordingly analyses drew on different subgroups of data, as outlined in Table 5.1.

Table 5.1 Study subgroup observations within the total cohort

Analysis	Child birth years	Data observation period	Child age at time of maternal incarceration
Description of children and mothers	1985-1996	1985-2014	0-17 years
Childhood prevalence[a]	1985-1996	1985-2014	0-17 years
	1985-2004	1985-2014	0-9 years
	1985-2009	1985-2014	0-4 years
Annual prevalence	1985-2011	2003-2011	0-17 years
	1985-2011	1995-2011	0-9 years
	1985-2011	1990-2011	0-4 years
Proportion of mother prisoners[b]	1985-2011	2003-2011	0-17 years

a Aboriginal status for WA population birth data only available from 1992
b Point in time estimate on 30 June annually

5.3.4 Analyses

Description of children and mothers

Descriptive statistics for children born 1985 to 1996 who were exposed to maternal incarceration aged 0-17 years were calculated, including Aboriginal status, sex, age,

socioeconomic status and remoteness of mother's place of residence at time of child's birth. Birth-date and sex were derived from Birth Registration data, or Midwives Notifications System data if birth data were unavailable.

Descriptive information on mothers were derived from the data, including Aboriginal status, age at imprisonment, number of cohort children, number and length of imprisonment terms, whether they were sentenced or unsentenced, and offence type.

Descriptive statistics of the full cohort born 1985 to 2011 are provided in Appendix E (Table E1).

Annual prevalence

Annual age-standardised rates of Aboriginal and non-Aboriginal WA children who experienced maternal incarceration while aged 0–17 years in 2003–2011, 0–9 years in 1995–2011 and 0–4 years in 1990–2011 (see Table 5.1), were calculated using population denominators derived from the Australian Bureau of Statistics (ABS).[30, 31] The rate of children aged 0–15 years affected by maternal incarceration in 2001 was calculated separately for comparison with existing New South Wales (NSW) estimates.[20]

Childhood prevalence

Prevalence of children who experienced maternal incarceration during childhood from birth to age 17 years, nine years and four years was calculated by birth years from 1985 to 1996, 2004 and 2009 respectively (see Table 5.1). Population denominators comprised the total number of live births in WA per year.[32] This analysis was stratified by Aboriginal status for children born from 1992 onwards as WA Aboriginal birth registration data are only available from 1992.[29]

Average annual percentage change in the rate of children affected across each time period was calculated using the following equation:

$$\frac{\left(\sum_{i=2}^{n} \frac{Rate_{Year\ i}}{Rate_{Year\ i-1}} - 1\right) \times 100}{n-1}$$

Where *n* is the total number of years, Year 1 is the first year and Year *n* is the last year.[33]

Proportion of WA female prisoners who are mothers

The proportion of women prisoners who are mothers (of children aged 0–17 years) at the time of their incarceration was calculated from the total number of female prisoners in WA identified in the ABS Prisoner Census for years 2003–2011.[22] The Prisoner Census is taken on 30 June each year, it includes all women remanded or sentenced to adult custodial corrective services in WA on that day. The number of mothers in prison on 30 June each year was calculated using mother's reception and discharge dates in the DCS data. Mothers in juvenile custodial facilities were excluded as they are not included in the Prisoner Census.[22]

5.3.5 Socioeconomic status classification

The Socioeconomic Indexes for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage (IRSD)[34] was used to assign area-based socioeconomic status of children's place of residence at time of birth. The IRSD score is a continuum where lower scores equate to relatively more measures of economic and social disadvantage within an area.

The smallest area of SEIFA reporting is Collectors District (CD) level, which is about 250 households or less in rural areas.[34] CD level scores were missing for 9.3% of the cohort. CD level is not available for certain areas, for example where low census response rates would jeopardise the representativeness of respondents.[35] Other examples for exclusion include very low levels of employment or where income could not be calculated in 70% or more households.[35] Missingness is therefore likely to be associated with disadvantage. For this reason, missing CD scores were first replaced with mean CD-score by postcode (7.9%) before using broader area scores of SEFIA available for Statistical Local Area or Local Government Area (1.1%).

5.3.6 Offence type classification

TOMS data provided the major offence type for prisoners using the Australian Standard Offence Classification (ASOC).36 The ASOC classifies offences within 16 Divisions using criteria based on the use of violence, aim, victim, seriousness and intent.[36]

5.3.7 Statistical analyses

Statistical analyses were undertaken in Stata version 14.0. Difference between Aboriginal and non-Aboriginal children and mothers' demographic characteristics were assessed using the Mann-Whitney test for continuous variables and a Pearson's chi-square for categorical variables.

Assumptions for the Mann-Whitney test were met as the dependent variables were ordinal or continuous, the independent variable consists of two independent groups, observations were independent, and all variables were not normally distributed as established from skewness and kurtosis tests for normality.[37]

Continuous variables were divided into categories to better describe the spread of the data. Pearson's chi-square test was used to assess differences between Aboriginal and non-Aboriginal groups for categorical variables. All assumptions for Pearson's chi-square test were met as observations were independent from each other and all cells had expected counts above five.[38]

5.3.8 Ethics approvals

Ethics approvals were obtained from the Department of Health Human Research Ethics Committee, the Western Australian Aboriginal Health Ethics Committee, and the University of South Australia Human Research Ethics Committee.

5.4 Results

Table 5.2 summarises the characteristics of the children within the total study population who reached 18-years of age during the study observation period. In total 4,818 children who were born in WA between 1985 and 1996 had their biological mother incarcerated at least once during their childhood, from birth to their 18th-birthday. Approximately two-thirds of children were Aboriginal. Aboriginal children (Mdn age = 5.8 years) were younger than non-Aboriginal children (Mdn age = 7.4 years) at first exposure to their mother's imprisonment, U= 7.59, p<0.001. Forty-five percent of Aboriginal children and 35% of non-Aboriginal children were first exposed by the age of four. Over half of the children were living in the 20% most disadvantaged areas. More Aboriginal children were in the most disadvantaged areas, χ^2 (4, N = 4811) = 461.78, p<0.001.

Table 5.2 Characteristics of children born in Western Australia (1985-1996) affected by maternal incarceration during childhood (0-17 years) and their mothers

Characteristics	Aboriginal n (%)	Non-Aboriginal n (%)	Total n (%)
Children characteristics			
Number of children	3122 (65)	1696 (35)	4818 (100)
Sex*			
Male	1567 (50)	902 (53)	2469 (51)
Female	1555 (50)	794 (47)	2349 (49)
Age at first exposure***			
Birth	29 (1)	15 (1)	44 (1)
0-4 years	1383 (44)	583 (34)	1966 (41)
5-9 years	835 (27)	482 (28)	1317 (27)
10-14 years	622 (20)	438 (26)	1060 (22)
15-17 years	253 (8)	178 (10)	431 (9)
Socio-economic level[a]***			
1 (least disadvantaged)	27 (1)	101 (6)	128 (3)
2	97 (3)	181 (11)	278 (6)
3	286 (9)	295 (17)	581 (12)
4	608 (19)	458 (27)	1066 (22)
5 (most disadvantaged)	2100 (67)	658 (39)	2758 (57)
Remoteness[a]***			
Major cities	1282 (41)	1234 (73)	2516 (52)
Inner regional	225 (7)	205 (12)	430 (9)
Outer regional	525 (17)	176 (10)	701 (15)
Remote	421 (14)	60 (4)	481 (10)
Very remote	664 (21)	14 (1)	678 (14)
Mother characteristics			
Number of mothers	1409 (56)	1102 (44)	2511 (100)
Number of children (total)[b]	4839 (66)	2490 (34)	7329 (100)
Number of exposed children[c]	4353 (90)	2424 (97)	6777 (92)
Children per mother (total)***			
1	265 (19)	404 (37)	669 (27)
2	281 (20)	313 (28)	594 (24)
3	240 (17)	212 (19)	452 (18)
4	245 (17)	96 (9)	341 (14)
5+	378 (27)	77 (7)	455 (18)
Exposed children per mother***			
1	365 (26)	419 (38)	784 (31)
2	287 (20)	324 (29)	611 (24)
3	248 (18)	197 (18)	445 (18)
4	206 (15)	92 (8)	298 (12)
5+	303 (22)	70 (6)	373 (15)
Age at imprisonment[d]***			
13-17 years	13 (1)	<5 (<1)	14 (1)
18-19 years	146 (10)	54 (5)	200 (8)
20-24 years	404 (29)	225 (20)	629 (25)
25-29 years	336 (24)	246 (22)	582 (23)
30-34 years	279 (20)	255 (23)	534 (21)
35-39 years	153 (11)	174 (16)	327 (13)
40+ years	78 (6)	147 (13)	225 (9)
Imprisonment characteristics			
Number prison records	5445 (65)	2619 (31)	8064 (100)
Records per mother***			
1	533 (38)	570 (52)	1103 (44)
2	263 (19)	227 (21)	490 (20)
3	154 (11)	111 (10)	265 (11)
4	89 (6)	74 (7)	163 (6)
5+	370 (26)	120 (11)	490 (20)

Imprisonments cont.			
Duration***			
< 24 hours	456 (8)	271 (10)	727 (9)
1-7 days	1536 (28)	645 (25)	2181 (27)
1-4 weeks	1356 (25)	535 (20)	1891 (23)
1-3 months	967 (18)	421 (16)	1388 (17)
3-6 months	563 (10)	340 (13)	903 (11)
6-12 months	367 (7)	223 (9)	590 (7)
1-2 years	160 (3)	135 (5)	295 (4)
2+ years	40 (1)	49 (2)	89 (1)
Sentence type[e]***			
Unsentenced	1880 (35)	1145 (44)	3025 (38)
Sentenced	3565 (65)	1474 (56)	5039 (62)
Offence type[f]***			
Homicide	50 (1)	22 (1)	72 (1)
Injury	1096 (21)	216 (9)	1312 (17)
Sexual assault	10 (<1)	18 (1)	28 (<1)
Endangerment	299 (6)	48 (2)	347 (4)
Abduction	49 (1)	25 (1)	74 (1)
Robbery/extortion	152 (3)	118 (5)	270 (3)
Unlawful entry	557 (11)	293 (12)	850 (11)
Theft	618 (12)	339 (13)	957 (12)
Fraud	118 (2)	347 (14)	465 (6)
Illicit drug	63 (1)	300 (12)	363 (5)
Weapons	17 (<1)	5 (<1)	22 (<1)
Property damage	138 (3)	34 (1)	172 (2)
Public order	269 (5)	39 (2)	308 (4)
Traffic regulatory	615 (12)	289 (11)	904 (12)
Justice procedures	1106 (21)	391 (16)	1497 (19)
Miscellaneous	53 (1)	32 (1)	85 (1)

Notes: [a]Missing socioeconomic data for 4 Aboriginal and 3 non-Aboriginal children, and remoteness data for 5 Aboriginal and 7 non-Aboriginal children. [b]Total number of children born to mother (to 2014). [c]Total number of children born to mother who were exposed to maternal incarceration between 1985 and 2014 while aged 0-17 years, proportion of total children born to mother. [d]Age of mother determined at imprisonment when first child entered the cohort during the study period. [e]'Sentenced' imprisonments can include a period where the prisoner is held on remand (unsentenced) before they were sentenced. [f]Offence data missing for 235 Aboriginal and 103 non-Aboriginal records of imprisonment. *$p<0.05$ ***$p<0.001$

Point prevalence of maternal incarceration for mothers of children aged 0–17 years on 30 June 2003 was 60.9% Aboriginal and 45.0% non-Aboriginal women prisoners, p=0.0214, prevalence ratio (PR) 1.35, 95%CI 1.05 to 1.74. On 30 June 2011 67.5% Aboriginal and 50.0% non-Aboriginal women prisoners were mothers, p=0.0009, PR 1.31, 95%CI 1.13 to 1.61. As shown in Table 5.2, there were 2,511 mothers with at least one child born 1985 to 1996 exposed to maternal incarceration in childhood. Aboriginal mothers (Mdn = 3) had higher numbers of children exposed to maternal incarceration within the total cohort than non-Aboriginal mothers (Mdn = 2), U= −11.63, p<0.001. Around two-thirds (65%) of non-Aboriginal mothers had 1–2 children in total (including non-exposed children) compared to two-fifths (39%) of Aboriginal mothers, whereas, one-quarter (27%) of Aboriginal mothers had five or more children compared with only 7% of non-Aboriginal mothers, χ^2 (4, N= 2,511) = 262.96, p<0.001.

Aboriginal mothers (Mdn age = 27.0 years) were younger than non-Aboriginal mothers (Mdn age = 30.5 years) at the time of their first imprisonment when their child was exposed to their incarceration, U= 10.173, $p<0.001$. Aboriginal mothers were two-times more likely to be aged less than 20 years, and ten-times more likely to be under 18 years of age. The age profile of Aboriginal and non-Aboriginal mothers differed across age groups in Table 5.2, χ^2 (6, N= 2,511) = 105.09, $p<0.001$.

In total, mothers had 8,064 records of imprisonment while their children (born 1985 to 1996) were aged 0–17 years. The number of imprisonments per mother was lower for non-Aboriginal mothers (Mdn = 1) than Aboriginal mothers (Mdn = 2), U= −9.32, $p<0.001$. Around half (56%) Aboriginal mothers had 1–2 imprisonments compared to 72% of non-Aboriginal mothers. While one-quarter (26%) of Aboriginal mothers were imprisoned 5–42 times, compared to 11% of non-Aboriginal mothers who were imprisoned 5–24 times, χ^2 (4, N= 2,511) = 103.81, $p<0.001$.

Aboriginal mothers had shorter prison stays (Mdn = 14.8 days) than non-Aboriginal mothers (Mdn = 20.8 days), U= 4.69, $p<0.001$. Patterns of length of imprisonments in Table 5.2 were similar for Aboriginal and non-Aboriginal mothers, but differed across all categories, χ^2 (7, N= 8064) = 97.11, $p=0.001$. Three-quarters (77%) of all mothers' imprisonment records were for three-months or less.

Length of imprisonment may be influenced by offence type which differed between Aboriginal and non-Aboriginal mothers (Table 5.2), χ^2 (15, N= 7,726) =1.1e+3, $p=0.001$. Aboriginal mothers were twice as likely to be detained for acts intended to cause injury or three-times as likely for endangerment offences than non-Aboriginal mothers. Similar proportions of Aboriginal and non-Aboriginal mothers' records were for breach of justice procedures. Fraud offences were more common amongst non-Aboriginal mothers, as were illicit-drug offences. Similar proportions of mothers were detained for unlawful entry with intent, theft and traffic offences. Homicide, sexual assault, abduction and weapons offences contributed to a small proportion of mothers' records. Sentence type differed between Aboriginal and non-Aboriginal mothers, χ^2 (1, N= 8064) = 63.74, $p<0.001$.

5.4.1 Annual prevalence of children experiencing maternal incarceration in WA

Figure 5.1 displays the annual age-standardised rates of WA children experiencing maternal incarceration in WA across the study period. The number of children affected each year, prevalence figures and prevalence ratios with 95%CIs are detailed in Appendix E (Table E2). Across 2003–2011 on average 1,544 WA children were affected by maternal incarceration each year, at a rate of 303 children per 100,000 population aged 0–17 years. As can be seen from the marked difference in scale between the two graphs in Figure 5.1, Aboriginal children aged 0–17 years were 27 times (95%CI 24.5–30.3) more likely to experience maternal incarceration across 2003–2011 with an average rate of 2,929 per 100,000 Aboriginal children (n=1,034) affected each year, compared to 108 per 100,000 non-Aboriginal children (n=510). Between 2003–2011 the average annual percent change was −0.9% for Aboriginal children, 1.8% for non-Aboriginal children, and −0.3% overall for all children aged 0–17 years.

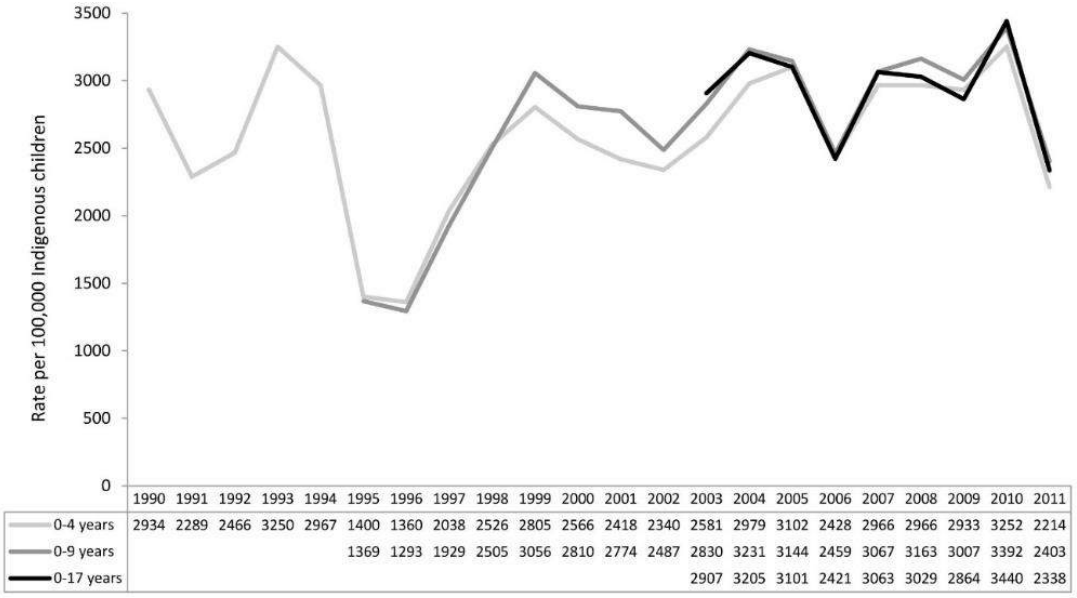
5.4.2 Childhood prevalence of maternal incarceration for children born in WA

Appendix E (Table E3) outlines the age-specific childhood prevalence figures for WA children by year of birth. Nearly one-fifth (18.8%, n=1,368) of Aboriginal children born in WA between 1992–1996 experienced maternal incarceration during childhood to age 17 years. In comparison, 0.7% (n=843) of non-Aboriginal children born during the same period were affected. Accordingly, Aboriginal children were 26 times (95%CI 23.9 to 28.2) more likely to be affected than their non-Aboriginal counterparts. The average annual percent change for children born between 1992–1996 was −7.3% for Aboriginal children, 1.1% for non-Aboriginal children, with an overall increase of 2.2%.

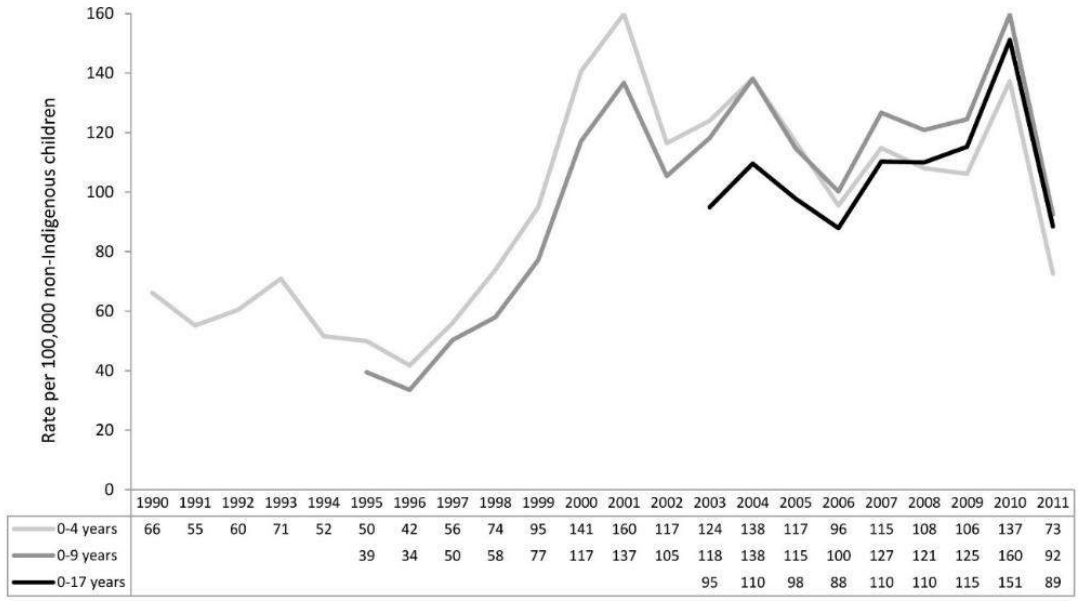
5.4.3 Comparison between WA and NSW estimates for children aged 0-15 years in 2001

Analysis of data of children aged 0–15 years affected by maternal incarceration in WA in 2001 was undertaken for comparison with published estimates of children affected in NSW.[20] Similar rates of non-Aboriginal children were affected in WA (108 per 100,000) and NSW (112 per 100,000) during 2001.[20] Twice the proportion of Aboriginal children were affected in WA (2,738 per 100,000) than NSW (1,449 per 100,000).[20] Comparison of data for children aged 0–15 years in 2001 who had ever experienced the incarceration of their mother throughout childhood, found a 2.4-fold

greater rate of Aboriginal WA children affected (8,838 per 100,000) compared to NSW estimates (3,689 per 100,000).[20] However, the difference in rates was 1.8-fold higher for non-Aboriginal children in NSW (599 per 100,000) than in WA (328 per 100,000).[20]



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0-4 years	2934	2289	2466	3250	2967	1400	1360	2038	2526	2805	2566	2418	2340	2581	2979	3102	2428	2966	2966	2933	3252	2214
0-9 years						1369	1293	1929	2505	3056	2810	2774	2487	2830	3231	3144	2459	3067	3163	3007	3392	2403
0-17 years														2907	3205	3101	2421	3063	3029	2864	3440	2338



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0-4 years	66	55	60	71	52	50	42	56	74	95	141	160	117	124	138	117	96	115	108	106	137	73
0-9 years						39	34	50	58	77	117	137	105	118	138	115	100	127	121	125	160	92
0-17 years														95	110	98	88	110	110	115	151	89

Figure 5.1 Age-standardised rates of Aboriginal and non-Aboriginal children affected by maternal incarceration each year, 1990-2011

5.5 Discussion

Using whole-population linked data this article provides the first census of children affected by maternal incarceration in an Australian State. It demonstrates that Aboriginal children and mothers are disproportionately affected. Across 2003–2011, WA Aboriginal children aged 0–17 years were 27 times (95%CI 24.5 to 30.3) more

likely to be affected than non-Aboriginal children. This disparity reflects higher rates of imprisonment of Aboriginal women[22] and their greater likelihood of being mothers at younger ages and with higher fertility rates.

Figure 5.1 illustrates annual prevalence across the study period. The drop in rate of Aboriginal children affected between 1994 and 1996, seen to a lesser extent for non-Aboriginal children, coincides with the enactment of the *Fines, Penalties and Infringement Notices Enforcement Act 1994* (WA).[39] The purpose of the Act was to reduce the use of imprisonment for non-payment of fines by providing alternative sentencing options such as licence suspension and property forfeiture.[40] Regarding the subsequent rise in rates seen from 1997, it has been postulated that the policy was not as effective at reducing imprisonment for low socioeconomic status women.[41, 42]

For children born between 1992 and 1996 there was a −7.3% decline in prevalence of Aboriginal children who experienced maternal incarceration by age 17-years, compared to a 1.1% increase for non-Aboriginal children. The denominator (number of WA births) is likely responsible for this apparent trend. Appendix E (Table E3) reports the number of children born each year who were affected by maternal incarceration throughout childhood. The number of children affected between birth years fluctuates within a relatively small range for both Aboriginal and non-Aboriginal children. However, from 1992 to 1996 the total number of Aboriginal births increased (n=1,215 to n=1,538), while non-Aboriginal births decreased (n=23,858 to n=23,255).[32]

The higher rates of Aboriginal children affected in WA annually and throughout childhood compared to NSW[20] is likely largely explained by higher rates of Aboriginal female imprisonment in WA (560 per 100,000 women) than NSW (391 per 100,000 women) in 2001.[22] This may in part reflect differences in offences, penalties and sentences imposed between the States. For example, a fine is the most common penalty for traffic related offences in WA (for which non-payment may result in imprisonment) whereas in addition to fines NSW imposes alternative penalties including ‘intensive supervision’ and ‘no conviction recorded’.[43]

Since our final study estimates in 2011 the rate of female imprisonment in WA has increased by 18%, with the number of Aboriginal women prisoners rising by 37% compared to 10% for non-Aboriginal women prisoners.[22] Accordingly, the disparity

reported here between Aboriginal and non-Aboriginal children and mothers has likely only been exacerbated.

Note that the increasing rate of Aboriginal female imprisonment is not necessarily associated with an equal increase in offending behaviours or criminality within the community. Analysis has found the predominant cause of increasing Aboriginal imprisonment within NSW is a more rigid response to Aboriginal offenders throughout the criminal justice system, such as in remand and sentencing practices.[44] This can be driven by socioeconomic factors such as homelessness, for example bail is often contingent on having stable accommodation which can result in offenders being detained on remand in instances where they would otherwise be released before trial.[45] As shown in this study, Aboriginal children were most likely to reside in the lowest 20% of socioeconomic areas, indicating the high level of disadvantage also experienced by their mothers.

The cohort generally experienced higher levels of socioeconomic disadvantage than the wider WA population. For Aboriginal cohort children, 67% resided in the lowest socioeconomic quintile compared to 46% of the WA Aboriginal population and 1% in the highest quintile compared to 6% of the WA Aboriginal population.[46] The difference was more pronounced for non-Aboriginal cohort children, with 39% in the lowest quintile compared to 11% of the WA non-Aboriginal population and 6% in the highest quintile compared to 28% of the WA non-Aboriginal population.[46]

Children are most likely to first experience maternal incarceration when aged less than five-years. This is a key time in child development. The attachment literature illustrates how maternal separation during this time can result in lasting impacts on children.[47] Specialised mother-baby programs facilitated within prisons have improved attachment outcomes for infants at-risk of disorganised attachment relationships.[12] The majority of WA women prisoners report that their children are cared for by family members while they are incarcerated.[2] Qualitative research has found children still experience significant disruption to their living and care arrangements during this time.[3, 48] Further research is required to understand children's outcomes and their relationship to the experience of maternal incarceration.

Internationally, cumulative risk of maternal imprisonment in childhood up to 14 years of age has been estimated in Denmark and the United States (US) using a single-year

birth cohort of all children born in 1990 using administrative registry data in Denmark and a number of sources of prisoner data in the US. Denmark estimates included prison stays less than 24 hours, as was our approach.[49] In Denmark, 2.2% of children born in 1990 experienced maternal incarceration by age 14-years.[49] In comparison, 1.6% of WA children born in 1990 experienced maternal incarceration by age 17 years. However, significant increases in the WA female prison population occurred throughout the mid-1990s[22] with a corresponding increase in the number of children affected as demonstrated in this article.

The US data was restricted to prison stays of over one year,[49] making comparisons with the current study difficult. One comparison that can be made is the level of racial disparity observed. In the US 0.6% of White and 3.3% of Black children born in 1990 were affected by maternal incarceration (of one-year or longer) by 14 years of age, a 5.5-fold difference.[49] For WA children born in 1992, 0.7% of non-Aboriginal and 23.7% of Aboriginal children were affected by any maternal incarceration by age 18 years of age, representing a 35-fold difference. This reinforces the magnitude of the disparity in Australia.

5.5.1 Limitations

Estimates of Aboriginal populations based on Australian census data and administrative data are affected by a number of factors.[29] Willingness to self-identify as Aboriginal is often dependent on the context of the service contact.[29] This affects the accuracy of Aboriginal population estimates and is more relevant for earlier study years. Best available data has been used in the identification of Aboriginal status for study participants through the WADLS best-practice algorithm[29] and in using the most recently available data for population denominators.

Motherhood was defined according to formal Birth Registration data, therefore any non-biological mothers were excluded. Similarly excluded were children who migrated to WA after birth, or children born in WA whose mothers were imprisoned outside WA. Likewise biological mothers were assumed to have a continuing relationship with their children from birth. The WA DCS conducted interviews with 64 female prisoners in 2008, including questions on motherhood.[2] They found 61% of respondents had children under 18 years of age,[2] which was the figure we derived for 30 June 2008, thereby providing some support for the study estimates.

The quality of linked administrative data can be affected by factors such as incorrect or missing links and completeness.[50] The WA Data Linkage Branch implements a number of processes to enhance data validity.[50]

SEIFA IRSD data was only available for the 1996, 2001 and 2006 censuses.[34] The CD level score for the census closest to an individual's record was used. Economic and social characteristics of an area can change over time, which may affect SEIFA accuracy for the eldest cohort members born from 1985.

5.6 Conclusion

Using population-wide linked administrative datasets, this article provides accurate, high quality data on the size of the population of children and mothers affected by maternal incarceration in WA over two decades. It highlights the overrepresentation of Aboriginal mothers and children within this population. Aboriginal children experience maternal incarceration at higher rates, at younger ages and more frequently throughout childhood.

This study is timely in extending knowledge of the children affected by maternal incarceration as the WA DCS has recently formed the Women's Estate Reference Committee to advise on policy to address the needs of the State's increasing women's prison population.[51] This presents an opportunity to develop criminal justice policies that help to prevent further entrenchment of disadvantage for vulnerable families.

5.7 References

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6 Study II
Descriptive Study of Infant Children of Women Prisoners in Western Australia

The study presented in this chapter addresses Research Aims 1 and 2 by determining the prevalence and characteristics of infant children (aged 0-1 years) of women prisoners in Western Australia, and comparing the rates of infant mortality and child protection system contact for children of women prisoners and children in the general community.

This chapter presents the study as published in *Health and Justice*. The citation for this published study is:

> Dowell, CM, Mejia, GC, Preen, DB & Segal, LS 2018, 'Maternal incarceration, child protection, and infant mortality: a descriptive study of infant children of women prisoners in Western Australia', *Health and Justice*, vol. 6, no. 2, DOI 10.1186/s40352-018-0060-y

The published version of the manuscript is presented in Appendix I.

Within the following chapter, the use of term 'Indigenous' in the manuscript version has been changed to 'Aboriginal' for consistency within the thesis.

6.1 Abstract

Rationale

There are no population statistics collected on a routine basis on the children of prisoners in Australia. Accordingly, their potential vulnerability to adverse outcomes remains unclear.

Objective

This study draws on linked administrative data to describe the exposure of children aged less than 2 years to maternal imprisonment in Western Australia, their contact with child protection services, and infant mortality rates.

Results

In Western Australia, 36.5 per 1000 Aboriginal (n = 804) and 1.3 per 1000 non-Aboriginal (n = 395) children born between 2001 and 2011 had mothers imprisoned after birth to age 2 years. One-third of infants' mothers had multiple imprisonments (maximum of 11). Nearly half (46%) of prison stays were for ≤2 weeks, 12% were between 2 and 4 weeks, 14% were for 1–3 months, and 28% were longer than three months. Additionally, 17.4 per 1000 Aboriginal (n = 383) and 0.5 per 1000 non-Aboriginal (n = 150) children had mothers imprisoned during pregnancy. Half of the children with a history of maternal incarceration in pregnancy to age 2 years came into contact with child protection services by their second birthday, with 31% of Aboriginal and 35% of non-Aboriginal children entering out-of-home care. Rates of placement in care were significantly higher for Aboriginal children (Relative Risk (RR) 27.30; 95%CI 19.19 to 38.84; $p < .001$) and for non-Aboriginal children (RR 110.10; 95%CI 61.70 to 196.49; $p < .001$) with a history of maternal imprisonment compared to children of mothers with no corrections record. Infant mortality for children whose mothers were imprisoned up to 5 years before birth or within their first year after birth was higher than for children of mothers with no corrections record for both Aboriginal (RR 2.36; 95%CI 1.41 to 3.95; $p = .001$) and non-Aboriginal children (RR 2.28; 95%CI 0.75 to 6.97; $p = .147$).

Conclusions

This study highlights the particular vulnerability of children whose mothers have been incarcerated and the importance of considering their needs within corrective services policies and procedures. Prison may present an opportunity to identify and work with vulnerable families to help improve outcomes for children as well as mothers.

6.2 Background

Children of prisoners are highly vulnerable. Prisoners experience elevated rates of adversity including mental illness, domestic violence, substance use disorders, poverty, homelessness, racism and discrimination.[1-3] These adverse experiences within a family environment are known to increase the risk of poor outcomes for children, particularly in the early years of infancy.[4] Studies have found children with incarcerated parents experience a range of issues such as poor developmental outcomes, behavioural problems, educational difficulties, and increased mortality.[5-9] Much of the literature on children of prisoners has been conducted within the United States, United Kingdom and Europe.[10] There is comparatively less known about the experience of children in other countries, including Australia. There is also relatively little evidence available on children of prisoners at a population level.

Within Australia, and beyond, there is no routine reporting of the prevalence of children affected by parental incarceration, nor their health or welfare.[11] Infant mortality is the most significant adverse outcome that can be experienced and is a strong marker of disadvantage and represents a measure of the health of a population.[12] There is a lack of information on infant mortality outcomes for women prisoners, as distinct from imprisoned fathers, due to their relatively smaller numbers.[13]

Child protection system contact is also an important measure of child welfare. Children with a history of placement in out-of-home care are at increased risk for a range of ongoing difficulties including mental illness, behavioural problems and poor school performance.[14, 15] In addition, information on the characteristics of children's exposure to parental incarceration is not readily available. There is no reporting on such characteristics as the duration and frequency of parental prison stays, or on the classification of parental offences. This information is important for establishing the health status and service needs of children of prisoners, and to inform future research priorities.

In the absence of formal population surveillance, data linkage provides a means for accurately describing the prevalence and characteristics of children of prisoners. Data linkage connects information relating to individuals within defined populations across multiple collections of data which are routinely recorded by government services and departments for primarily administrative purposes, such as hospital admission data or

records of births, deaths and marriages.[16] Data linkage can provide retrospective coverage of entire populations of interest, while maintaining the confidentiality of individuals, making it highly suitable for investigating marginalised groups such as the prisoner population, and rare outcomes such as infant mortality.

This study draws on linked data to provide key descriptive statistics for the population of infant children of women prisoners in Western Australia. Infants are a priority population given their vulnerability and unique developmental considerations. Infants have an absolute reliance on caregivers for their basic needs, lack communication skills, and have less structured contact with community services, such as schooling, where at-risk individuals may be identified. Experiences of adversity during pregnancy and infancy have significant and long-term consequences for child health and development. Exposure of the fetus during pregnancy or of the infant after birth to factors such as poor nutrition and maternal alcohol and drug abuse, domestic violence, and maternal stress has been shown to result in poor health outcomes including low birth weight, infant mortality and developmental delay.[17-19] Women prisoners have increased risk of poor pregnancy outcomes including low birth weight infants when compared to women in the general community, as well an increased risk of disrupted attachment with their infants.[20, 21] Despite their vulnerability, it is not known with any certainty how many Australian children experience the imprisonment of their mother in pregnancy or infancy, or the degree to which infants with a history of maternal imprisonment experience higher rates of mortality or child protection contact than infants in the general community.

There are also limited data on the infant children of Australian Aboriginal women prisoners, despite their overrepresentation in the prison population. In Western Australia, for example, Aboriginal peoples represent 4% of the general population but 46% of the female prison population.[22, 23] Aboriginal children are also overrepresented in the Australian child protection system. Similarly, Aboriginal peoples in Australia experience poorer pregnancy outcomes compared with non-Aboriginal mothers, and while infant mortality rates have improved across time for both Aboriginal and non-Aboriginal populations, a racial disparity remains.[24] This reflects the high levels of disadvantage and discrimination experienced by Aboriginal peoples in Australia stemming from the historical and continuing impacts of colonisation, such as land dispossession, racism, and the forced removal of children from their families.[25]

Accordingly this study will provide a description of the population of infant children of Western Australian women prisoners including details of the characteristics of exposure of infant children (aged less than 2 years) to maternal imprisonment, as well as measuring child protection system contact and infant mortality rates for the population.

6.3 Methods

6.3.1 Aims

This study draws on whole-population linked administrative data to examine maternal incarceration exposure, child protection system contact, and mortality rates for infant children of Western Australian women prisoners.

Aim 1: To describe the features of maternal incarceration exposure including the proportion of women prisoners who are pregnant; the prevalence of children exposed to maternal incarceration between birth and before age-2; and offence type and length and frequency of maternal imprisonments for children between birth and before age-2.

Aim 2: To describe contact with the child protection system before 2 years of age for children whose mothers have a record of imprisonment during pregnancy or before the child's second birthday and for children whose mothers have no corrections record.

Aim 3: To determine infant mortality rates for children of women with a history of imprisonment 5 years before birth or within their first year after birth and for children whose mother had no contact with corrective services.

6.3.2 Data sources

Data were obtained through the Western Australian Data Linkage System (WADLS). The WADLS uses highly accurate computerised probabilistic matching with clerical review to create linkages between administrative data collections across a range of Western Australian government departments and services.[16] For the present study, records were extracted from the Midwives Notifications System, Birth Registrations, Death Registrations, Department of Justice, and Department of Communities: Child Protection and Family Support data collections. These are all State-wide and statutory data collections with good coverage of the Western Australian population.

The Birth Registration and Midwives Notifications System data provides social and demographic characteristics of mothers and children at time of birth. Death data includes all deaths registered in Western Australia. The Department of Justice data collections include all custodial records for offenders held in Western Australian prisoners or under supervision of the Department on community-based correctional orders. The Department of Communities: Child Protection and Family Support data includes all reports of concerns for child welfare made to the child protection system and the details of investigations, protection applications and orders as well as placements in out-of-home care.

6.3.3 Study population

The study population was drawn from a retrospective longitudinal cohort study of all children born in Western Australia between 1985 and 2011 whose biological mother was imprisoned at least once between their date of birth and 18th-birthday, identified using the Midwives Notification System and Registry of Births in conjunction with linked Department of Justice prison data. For a description of the full cohort see Dowell, Preen, and Segal.[26] The cohort study included a randomly sampled comparison group of children whose mother had no record of imprisonment from their birth to their 18th-birthday, which was identified through the same data sources as the cohort and matched 3:1 to cohort children on Aboriginal status, age and gender.

The present study focused on a subset of children within the full cohort born from 2001 onwards. This time period was chosen due to substantial changes in the annual prevalence of children affected by maternal incarceration in Western Australia in the 1990s.[26] To address the three study aims, we have conducted three separate analyses all of which have slightly different observation periods, and hence different study populations, as summarised in Table 6.1. All analyses were stratified by Aboriginal status given differences between Australian Aboriginal and non-Aboriginal populations in terms of their demographic characteristics, health status, sentence type and unique cultural contexts.

Table 6.1 Observation periods for key analyses

Aim/Analyses	Maternal imprisonment observation period	Child birth years	Data observation years	Prison group n	Comparison group n
1. Maternal incarceration exposure					
In pregnancy	Pregnancy	2001–2011	2000–2011	533	–
In infancy	Birth to age < 2	2001–2011	2001–2013	1199	–
2. Child protection system contact					
All children	Pregnancy to age < 2	2001–2011	2000–2017	1383	6714
3. Infant mortality rates					
All children	5-years pre-birth to age < 1	2001–2011	1996–2012	1794*	6714*
Aboriginal children (Fig. 2)	5-years pre-birth to age < 1	1992–2011	1987–2012	2300*	7193*

***Also includes infants born in 2000 (n<5) or 1991 (n<5) who died in 2001 or 1992 while aged <1yr**

To address aim 1, maternal incarceration exposure was described for pregnancy and after birth to before age 2-years separately, because of the different implications of imprisonment for unborn and infant children. The study population included children born 2001–2011 whose mother was imprisoned in pregnancy between 2000 and 2011 (n = 533) and children whose mother was imprisoned from birth to before age-2 between 2001 and 2013 (n = 1199). There were 349 children within both groups who were exposed to maternal imprisonment in pregnancy and after birth before age-2. Mothers could have multiple children who met the inclusion criteria.

To address aim 2, child protection system contact was described from the start of pregnancy through to before age-2, as it is possible for child protection notifications to be raised for unborn children in Western Australia.

To address aim 3, we studied children born 2001-2011 to mothers with a history of imprisonment 5-years before birth to age-1 (n=1792) as infant mortality is a rare outcome in Australia and there were not sufficient numbers of infant deaths to limit analyses to children of mothers imprisoned in pregnancy and their first year. Accordingly, the analyses explore the population characteristics and mortality outcomes of children whose mothers have a history of imprisonment. Not all children in our defined at-risk group will be directly exposed to maternal imprisonment in utero or after birth. Infant mortality rates for Aboriginal children born from 1992 onwards were calculated in order to illustrate the change in rates over time. A similar calculation was not possible for non-Aboriginal children, due to small numbers. Western Australian

birth data for population denominators are only available by Aboriginal status from 1992 onwards.[27]

The comparison groups were also stratified by Aboriginal status and limited to children whose mothers never had a record in any Department of Justice data collection (including for community-based correctional orders) at any time during the period from 1985 to 2014. These groups were selected to describe the difference in child protection system contact and infant mortality between infants of women prisoners and infants within a general community sample with no maternal corrections history.

6.3.4 Analyses

Maternal incarceration exposure

The proportion of women prisoners who are pregnant was calculated from the total number of Western Australian women prisoners using Australian Prisoner Census data.[22] As the Prisoner Census records the prison population on a single day (30 June) each year, the numbers of pregnant women in custody on 30 June annually were identified from the study data using mothers' prison reception and discharge dates and children's birthdates. Pregnancy start date was calculated as being nine months before child birth-month, as child birthdate was provided to month of birth only and gestational age was not available.

The prevalence of children whose mother was imprisoned during their infancy (birth to age 2-years) was calculated for Aboriginal and non-Aboriginal children born in Western Australia across the period of 2001 to 2011 using population birth data from the ABS.[27] The number, length and nature of offence for maternal imprisonments during infancy, were described using child birth and death dates, mother prison reception and discharge dates, sentence type, and major offence type using the Australian and New Zealand Standard Offence Classification.[28] Maternal imprisonments included both juvenile and adult sentenced offenders and remandees held in Western Australian prisons.

Child protection system contact

Child protection system contact was defined as any record within the Western Australian Department of Communities: Child Protection and Family Support database for reports made to the Department concerning a child's welfare, applications or orders

for a child's protection, and periods of out-of-home care (including for respite care as well as child maltreatment).

The proportion and rate (per 1000) of children who had any child protection contact (including out-of-home care) was calculated for children whose mother had a record of imprisonment during pregnancy and/or from birth to age 2-years, and for those whose mother never had a corrections record. The proportion and rate of children who were placed in out-of-home care was also calculated.

Infant mortality

Infant mortality rate is commonly defined as "the number of deaths under one year of age occurring among the live births in a given geographical area during a given year, per 1000 live births occurring among the population of the given geographical area during the same year".[29] All children within the study population were live-born. Infant mortality rates (per 1000) across the period 2001–2011 were calculated for children with a history of maternal imprisonment and children of mothers with no corrective services history stratified by Aboriginal status.

Infant mortality rates were calculated for Aboriginal children born from 1992 to 2011 using 6-year moving averages (e.g. 1992–1997, 1993–1998, etc.) and presented for children of mothers with an incarceration history, children of mothers with no history of corrective services contact, and for all Western Australian Aboriginal children, the latter using ABS data.

6.3.5 Aboriginal status

Aboriginal status for children and mothers in the study populations was provided through the Derived Indigenous Status Flag variable generated by the WADLS using best-practice algorithms, which assess individuals' Aboriginal status across multiple data collections to enhance accuracy.[30]

6.3.6 Offence type

Major offence type is recorded in the Department of Justice data collections using the Australian and New Zealand Standard Offence Classification, which contains 16 Divisions classified according to the offence aim, use of violence, victim, seriousness and intent.[28] For the present study, offence type were described in six categories:

Offences against the person (Divisions 1–5); Theft and related (Divisions 6–8); Fraud and related (Division 9 and bribery offences); Drug (Division 10 and licit drug offences); Public order (Divisions 11–13 and 16); Traffic and related (Division 14, and driving under the influence of alcohol or other substance, dangerous or negligent driving offences); and Breach of justice procedures (Division 15).

6.3.7 Socioeconomic status and geographical remoteness

The Socio-economic Indexes for Areas Index of Relative Socio-economic Disadvantage[31] and the Accessibility/Remoteness Index of Australia[32] were used to describe infant's socioeconomic status and geographical remoteness of their place of residence at time of birth.

6.3.8 Statistical analysis

All statistical analyses were performed in Stata version 14.0 and stratified by Aboriginal status. The analyses were undertaken to establish whether the study populations differed in terms of their key characteristics. Pearson's chi-square was used to assess the difference between study sub-populations' basic demographic characteristics including sex, socioeconomic status, and geographical remoteness. A log-binomial regression model was applied to the child protection and infant mortality data to obtain risk ratios for comparing children of women prisoners with children whose mothers had no corrections record.[33-35]

6.4 Results

6.4.1 Descriptive characteristics of the study sub-populations

Table 6.2 describes the basic demographic characteristics of the study populations. Within the Aboriginal and non-Aboriginal populations, there were no statistically significant differences ($p > .05$) between the two maternal imprisonment history subgroups across all characteristics. Likewise, within each of the Aboriginal and non-Aboriginal populations, there were no significant differences with respect to the sex distributions of the groups of infants with maternal imprisonment histories to those with no maternal corrections record. In both the Aboriginal and non-Aboriginal populations, infants with a history of maternal imprisonment had different distributions of socioeconomic status and geographical remoteness in comparison to infants with no maternal corrections history.

Table 6.2 Descriptive characteristics of the study sub-populations, by Aboriginal status

	Aboriginal			Non-Aboriginal		
	Maternal imprisonment		No maternal corrections %	Maternal imprisonment		No maternal corrections %
	Pregnancy to <2yrs %	5yrs before birth- <1yr %		Pregnancy to <2yrs %	5yrs before birth- <1yr %	
Sex						
Male	50.2	50.4	52.4	50.8	51.3	48.0
Female	49.8	49.6	47.6	49.2	48.7	52.0
Socioeconomic status						
Most disadvantage, 0–20%	58.7	58.5	60.0	42.0	42.9	20.5
21–40%	21.7	22.4	21.3	22.7	21.3	23.2
41–60%	11.8	11.8	8.9	18.1	16.5	16.3
61–80%	4.6	4.7	7.0	9.6	11.6	22.6
Least disadvantage, 81–100%	3.2	2.6	2.8	7.6	7.7	17.3
Geographical remoteness						
Major cities	59.1	59.1	32.2	81.9	81.5	70.6
Inner regional	4.5	5.5	7.4	11.5	11.2	12.3
Outer regional	13.4	15.3	16.9	5.3	5.7	10.1
Remote[a]	11.0	9.6	20.4	1.4	1.6	7.0
Very remote[a]	12.0	10.5	23.2			
Infants (n)	944	1283	2923	439	511	3791

Notes

[a] 'Remote' and 'Very remote' categories combined for non-Aboriginal due to cell counts of *n*<5

6.4.2 Maternal incarceration exposure

Pregnancy

Between 2001 and 2011, 5.7% of Aboriginal and 4.0% of non-Aboriginal Western Australian female prisoners were pregnant while imprisoned. Over the same period 383 Aboriginal (17.40 per 1000) and 150 non-Aboriginal (0.49 per 1000) children were born to mothers who were imprisoned at least once while pregnant with them.

Birth to two-years

Table 6.3 provides a summary of children's exposure to maternal incarceration in infancy. In total, 804 Aboriginal and 395 non-Aboriginal children had a mother imprisoned at least once between their birth and their second birthday, equating to 36.52 per 1000 Aboriginal and 1.29 per 1000 non-Aboriginal children born in Western Australia between 2001 and 2011. Of these children, 30% of Aboriginal and 27% of non-Aboriginal, also had their mother imprisoned while pregnant with them.

For most children exposed to maternal incarceration between birth and age 2-years, their mothers were imprisoned just once (63% Aboriginal and 75% non-Aboriginal children). The mean (SD) length of incarceration was 97 (184) days but the distribution

was highly skewed, with half of all mothers' prison stays being for periods less than three-weeks with a median (IQR) of 19 (4–110) days.

Table 6.3 Maternal incarceration exposure in infancy (birth to age 2-years) for Western Australian children born 2001–2011

	Aboriginal		Non-Aboriginal	
Characteristics	n	%	n	%
Child experiences of maternal incarceration				
Mother imprisoned in infancy (not pregnancy)	561	69.8	289	73.2
Mother imprisoned in infancy and pregnancy	243	30.2	106	26.8
Number of maternal imprisonments in infancy, per child				
1	509	63.3	297	75.2
2	170	21.1	65	16.5
3	66	8.2	20	5.1
4+	59	7.3	13	3.3
Percentage of child's infancy mother was imprisoned				
0–5%	428	53.2	202	51.1
6–25%	203	25.2	104	26.3
26–50%	114	14.2	70	17.7
51–75%	47	5.8	14	3.5
76–100%	12	1.5	5	1.3
Length of maternal prison stays[a]				
Up to 2 weeks / 0–14 days	620	46.7	234	43.0
2–4 weeks / 15–30 days	154	11.6	63	11.6
1–3 months / 31–90 days	186	14.0	80	14.7
3–6 months / 91–180 days	138	10.4	61	11.2
6–12 months / 181–365 days	147	11.1	68	12.5
Greater than 1 year / 366+ days	82	6.2	38	7.0
Sentence type[a]				
Unsentenced – remand	683	51.5	265	48.7
Sentenced – default of fine	250	18.8	91	16.7
Sentenced – other	394	29.7	188	34.6
Offence type[ab]				
Against the person	361	29.3	87	16.6
Theft and related	389	31.6	162	30.9
Fraud and related	39	3.2	59	11.3
Drug offences	12	1.0	45	8.6
Public order	45	3.7	12	2.3
Traffic and related	173	14.0	59	11.3
Breach of justice procedures	213	17.3	100	19.1

[a]1871 maternal prison records in infancy (1327 Aboriginal and 544 non-Aboriginal)
[b]115 prison records missing offence type (95 Aboriginal and 20 non-Aboriginal)

The level of exposure varied considerably across the population of children exposed to maternal incarceration with 37% of Aboriginal and 25% of non-Aboriginal children experiencing multiple (up to 11) periods of maternal incarceration during infancy. For 22% of Aboriginal and 23% of non-Aboriginal children, their mother was imprisoned in total for more than a quarter of their life to age 2-years.

As shown in Table 6.3, mothers of children aged less than 2-years are more frequently imprisoned for non-violent offences related to theft, breach of justice procedures, and

traffic offences. Offences against a person (e.g., acts intended to cause injury) accounted for 29% of Aboriginal and 17% of non-Aboriginal mothers' imprisonments.

6.4.3 Child protection system contact

As shown in the Table 6.4, a considerably higher proportion of children had contact with the Western Australian child protection system by their second birthday if their mother was imprisoned during pregnancy or infancy, compared with children whose mother never had any involvement with corrective services.

For children born between 2001 and 2011 with a history of maternal imprisonment in pregnancy or infancy, 537 (568.9 per 1000) Aboriginal and 243 (553.5 per 1000) non-Aboriginal children came into contact with the child protection system by their second birthday. Of those children, 291 (31%) Aboriginal and 153 (35%) non-Aboriginal children were removed and placed in out of home care by age 2.

Table 6.4 Child protection system contact before and after age 2 years, by maternal imprisonment history

	Aboriginal children				Non-Aboriginal children			
	Maternal imprisonment		No corrections record		Maternal imprisonment		No corrections record	
Child protection contact	n	%	n	%	n	%	n	%
Child protection contact by age-2	537	56.9	208	7.1	243	55.4	74	2.0
Out-of-home care by age-2	*291*	*30.8*	*33*	*1.1*	*153*	*34.9*	*12*	*0.3*
No child protection contact by age-2	407	43.1	2715	92.9	196	44.6	3717	98.0
Child protection contact age-2+	*213*	*22.6*	*527*	*18.0*	*84*	*19.1*	*145*	*3.8*
Out-of-home care age-2+	*78*	*8.3*	*67*	*2.3*	*30*	*6.8*	*20*	*0.5*
Total	944	100	2923	100	439	100	3791	100

In comparison to children whose mothers had no corrections involvement, children of mothers with a prison record in pregnancy or infancy were 8-times (RR 7.99; 95%CI 6.93 to 9.22, $p < .001$) and 28-times (RR 28.36; 95%CI 22.29 to 36.08, $p < .001$) more likely to have contact with the child protection system by age 2 years for Aboriginal and non-Aboriginal children respectively. Rates of placement in out-of-home care by age-2 were 27-times (RR 27.30; 95%CI 19.19 to 38.84, $p < .001$) greater for Aboriginal and 110-times (RR 110.10; 95%CI 61.70 to 196.49, $p < .001$) greater for non-Aboriginal children whose mothers had a prison history during pregnancy to age 2-years compared to children whose mothers had no contact with corrections.

For the children of mothers with a record of imprisonment in pregnancy or infancy who had no child protection contact by age 2-years, a further 23% Aboriginal and 19% non-Aboriginal had child protection contact after their second birthday. A further 8% of Aboriginal and 7% of non-Aboriginal children had spent time in out-of-home care. This compared with 18% Aboriginal (2% out-of-home care) and 4% non-Aboriginal (0.5% out-of-home care) for children of mothers with no record of corrections contact.

By the end of the observation period in 2017, 21% of Aboriginal and 26% non-Aboriginal children with maternal imprisonment history in pregnancy or infancy had no child protection contact. This compares with 75% of Aboriginal and 94% of non-Aboriginal children of mothers with no corrections involvement.

6.4.4 Infant mortality

Across 2001–2011, Western Australian children whose mothers had a history of imprisonment prior to their birth (up to five years prior) or within their first year of life had an infant mortality rate of 22.6 deaths per 1000 Aboriginal births and 7.8 deaths per 1000 non-Aboriginal births. Infant mortality rates were higher for children of women prisoners compared to children of mothers who had no contact with corrective services by 2.36-times (95%CI 1.41 to 3.95, $p = .001$) for Aboriginal and 2.28-times (95%CI 0.75 to 6.97, $p = .147$) for non-Aboriginal children.

Figure 6.1 shows the temporal change and difference in infant mortality rates between Aboriginal children whose mother had a history of imprisonment and those whose mother had no corrections record, as well as the Western Australian average for Aboriginal children. Between 1992 and 97 and 2006–11, infant mortality rates for Western Australian Aboriginal children reduced by 56% overall and by 40% for children with maternal prison history, while there was less change in rates for children with no maternal corrections history with a 25% reduction over the period.

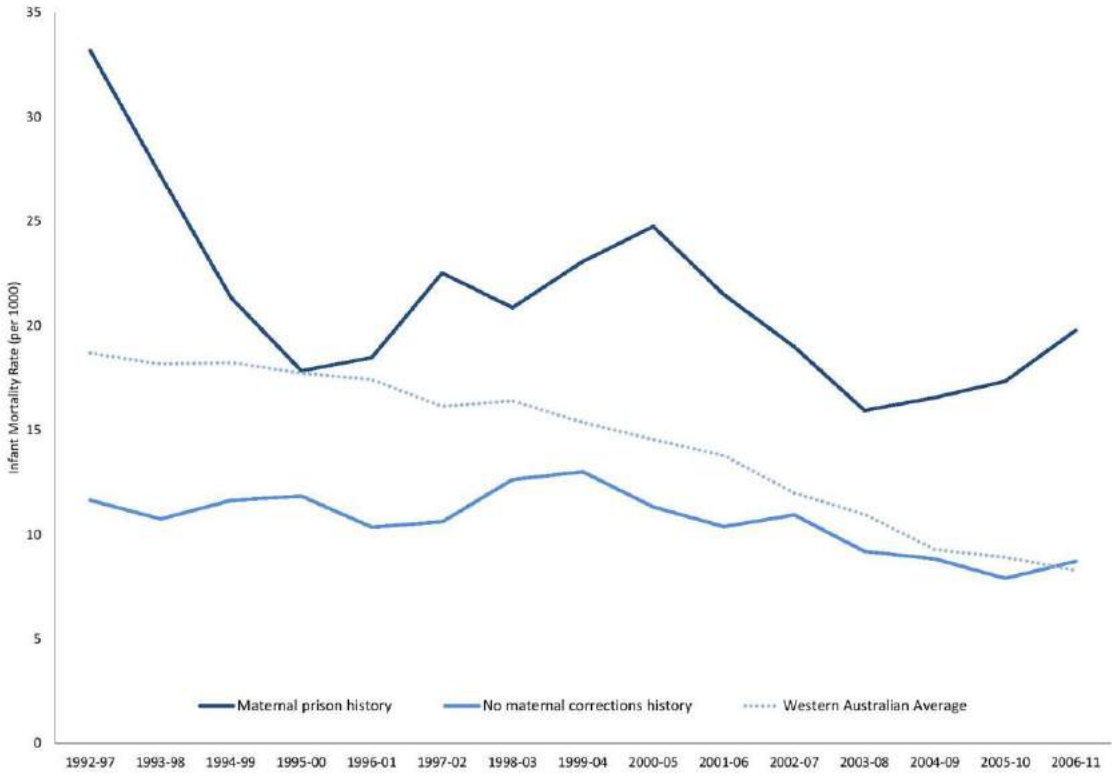


Figure 6.1 Aboriginal infant mortality rate by maternal corrections history, Western Australian children born 1992-2011 (6-year average)

6.5 Discussion

A major finding of the study is that 1 in 3 children whose mothers were imprisoned during pregnancy or their first two years of life, were placed in out-of-home care by their second birthday. In contrast only 1 in 100 Aboriginal and 1 in 300 non-Aboriginal children whose mothers had never been in contact with corrective services were placed in out of home care by the same age. While parental imprisonment has been recognised as a factor that contributes to infants and children being placed in care,[36] the extent to which the population of women prisoners have children placed in care has not been previously quantified in Australia.

In our study, half of all imprisonments were for unsentenced mothers being held in custody on remand. In such circumstances it is possible mothers may not have time to arrange care for their children following their arrest.[37, 38] Nearly half of all imprisonments of mothers whose children were aged less than 2 years were for two-weeks or less. This raises the question of if and how the length of a mother's prison stay impacts on the likelihood of child protection contact. Prisoners held on remand or for

short periods would be difficult to capture in prospective research and so have not featured much in prior studies. The assumption is often that longer periods of imprisonment are potentially more harmful for young children, as in theory they are more likely to lead to disrupted attachment. But it is possible that shorter imprisonments, and unplanned detention in the case of remandees, create a greater disruption for already vulnerable families. Questions have been raised about the utility of short-term imprisonment in general.[39, 40] The data reported in this study highlight the importance of considering the value of very short-term maternal imprisonments. Such periods are unlikely to allow for any participation in rehabilitative programs and may increase the likelihood of children coming into contact with the child protection system, although whether such contact is helpful or harmful to the child is not known.

One in six of the maternal imprisonments in the cohort were for non-payment of fines. While nearly a third of maternal imprisonments for the Aboriginal population were for violent offences against the person, a significant number of imprisonments for both Aboriginal and non-Aboriginal mothers were for non-violent crimes and fine default. There was legislative action taken to reduce imprisonments for non-payment of fines in Western Australia in the mid-1990s with the enactment of the *Fines, Penalties and Infringement Notices Enforcement Act* 1994 (WA).[41] This appeared to lead to a significant reduction in maternal imprisonments from 1994 to 1996,[26] although the current study demonstrates that default of fine remains a common reason for imprisonment of Western Australian women prisoners with young children. The Western Australian legislation has since been described as having "a discriminatory and disproportionate effect, leading to the over-representation of Aboriginal and Torres Strait Islander peoples, poor people and vulnerable people, in the Western Australian prison system".[42] Female prisoners are more frequently imprisoned for default of fine than male prisoners in Western Australia.[43] Three-quarters of women imprisoned for fine default in Western Australia are not employed, in comparison to 10% of males.[43] Socioeconomic factors including homelessness can also lead to prisoners being detained on remand in circumstances where they would otherwise be released before trial.[44] While it is well established that women prisoners experience high levels of socioeconomic disadvantage, the policy discussion around short term, remand, and fine default imprisonments has not extended to consider the potential implications of these for children with incarcerated mothers.

We found that for children aged less than 2 years, rates of contact with the child protection system were almost identical for Aboriginal and non-Aboriginal children whose mothers were imprisoned during pregnancy or before their second birthday. However, twice the number of Aboriginal compared to non-Aboriginal children had their mother imprisoned between pregnancy and their second birthday. This is of concern given that less than 7% of Western Australian children under 4 years old are Aboriginal.[23] The over-representation of Aboriginal children within the child protection system has been well established.[45] Our study findings raise the question of how much of the over-representation of young Aboriginal children in the child protection system may be related to the over-representation of Aboriginal women in the prison system. The removal of Aboriginal children from families is a pertinent issue in Australia, with some commentators expressing concerns in the wake of the rise in numbers of Aboriginal children in care.[46]

It would be valuable to explore whether there is any association between the timing of maternal incarceration and child protection contact but this is beyond the scope of the present paper given the complexities we have reported of prison exposure in terms of frequency and duration, and taking account of similar complexities of the timing, frequency and nature of child protection system contacts, familial relationships and additional contributing factors. The magnitude of our findings suggest the interaction between maternal incarceration and exposure of children to the child protection system is significant. The relationship between maternal incarceration, child protection and juvenile justice system involvement is clearly an important area for future research.

Our study found that infant mortality rates for children of mothers with a history of imprisonment were over twice the rate for children of mothers with no corrections record. This equated to an additional 13.1 deaths per 1000 Aboriginal births and 4.4 deaths per 1000 non-Aboriginal births, for children whose mothers have a history of imprisonment. While we were unable to calculate rates for women imprisoned during pregnancy separately, the international literature on the birth outcomes of women imprisoned during pregnancy has found improved birth outcomes, including birth weight, for women imprisoned during pregnancy compared to women imprisoned at other times and worse birth outcomes compared to women who are never imprisoned.[20] However, these findings were not replicated by the only Australian study to date by Walker, Hilder, Levy, and Sullivan,[47] which found similarly poor birth outcomes for

women imprisoned while pregnant compared to women imprisoned at other times. The authors questioned whether this was in part due to the shorter imprisonment terms within the New South Wales female prison population compared to those in the United States.[47] Our findings highlight the increased risk of infant mortality for children born to mothers with a history of imprisonment. Further research is needed, however, to establish whether the experience of maternal incarceration itself increases children's infant mortality risk, or whether it is acting as a marker of extreme vulnerability.

6.5.1 Limitations

The sampling methodology for the broader longitudinal study, from which the data were drawn, primarily identified children whose mothers had at least one record of imprisonment after their birth to their 18th-birthday. While it was possible to identify women who were imprisoned while pregnant, the sample did not include a full census of women imprisoned during pregnancy in Western Australia. Possible implications of this would be an underreporting of the proportion of Western Australian female prisoners who are pregnant, however, we found similar proportions of female prisoners who are imprisoned while pregnant as Australian-wide data.[48] Thus, any error is likely to be small.

Data were not available on gestational age and the day of birth, accordingly the date of commencement of pregnancy was taken as nine-months before the first day of a child's birth month. This may have included some mothers who were not yet pregnant at time of imprisonment, but were at least nine months away from giving birth. Research has shown, however, that the preconception period (approximately 6 months prior to conception) is also an important time when the experience of maternal stress during this period can impact on the health of the conceived child.[49]

6.6 Conclusions

This is the first Australian study to report the extent of the population of infant children of women prisoners in contact with the child protection system. The results confirm that infant children of women prisoners are a highly vulnerable population who experience a significantly increased risk of engagement with the child protection system and placement in out-of-home care. These children also experience high rates of infant death compared to children of mothers with no corrective services history. The findings also

demonstrate that many imprisoned mothers of young children are held on remand, for short periods of time and for non-violent crimes. This study highlights the importance of considering the heterogeneity of timing and frequency of imprisonment within the prison population on outcomes for families and children.

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7 Study III
Determinants of Infant Mortality for Children of Women Prisoners

The study contained in this chapter addresses Research Aims 2 and 3 by comparing the rates of infant mortality between children of women prisoners and children with no maternal corrections exposure, and establishing whether maternal imprisonment during pregnancy is a determinant of infant mortality.

The study is presented as published in *BMC Pregnancy and Childbirth*. The citation for this published study is:

> Dowell, CM, Mejia, GC, Preen, DB & Segal, LS 2018, 'Determinants of infant mortality for children of women prisoners: a longitudinal linked data study', *BMC Pregnancy and Childbirth,* 18:202, DOI 10.1186/s12884-018-1840-z

The published version of the manuscript is presented in Appendix I.

Within the following chapter, the use of term 'Indigenous' in the manuscript version has been changed to 'Aboriginal' for consistency within the thesis.

7.1 Abstract

Rationale

There is limited information on the determinants of infant mortality outcomes for the children of women prisoners.

Objective

This study aimed to explore determinants of infant mortality for Aboriginal and non-Aboriginal children, with a specific focus on maternal imprisonment during pregnancy as a risk factor.

Methods

Using linked administrative data we obtained a longitudinal sample of 42,674 infants born in Western Australia between October 1985 and June 2013. Data were analysed by maternal contact with corrective services, including; (i) imprisonment during pregnancy, (ii) imprisonment before (but not during) pregnancy, (iii) imprisonment after birth, (iv) community-based correctional orders (but no imprisonment), and (v) no corrections record. Infant mortality rates were calculated. Univariate and multivariate log-binomial regression was undertaken to identify key demographic and pregnancy-related risk factors for infant mortality. Risk factor prevalence was calculated for infants by maternal corrections history.

Results

430 Aboriginal and 116 non-Aboriginal infants died aged 0-12 months. For singletons, infant mortality rates were highest in Aboriginal infants with mothers imprisoned during pregnancy (32.1 per 1,000) and non-Aboriginal infants whose mothers were first imprisoned after birth (14.2 per 1,000). For all Aboriginal children, the strongest determinants of infant mortality were: abruptio placentae and other placental disorders (RR=2.85; 95%CI 1.46-5.59; p=0.002), maternal imprisonment during pregnancy (RR=2.55; 95%CI 1.69-3.86; p<0.001), and multiple gestation (RR=2.29; 95% CI1.51-3.46; p<0.001). Aboriginal and non-Aboriginal infants with mothers imprisoned at any time, and particularly before or during pregnancy, experienced higher prevalence of key pregnancy risk factors.

Conclusions

This is the first comprehensive study of the determinants of infant mortality for children of women prisoners. Infants with any maternal corrections history, including community-based orders or imprisonment outside of pregnancy, had increased infant mortality. Aboriginal infants whose mothers were imprisoned during pregnancy were at particular risk. There was a low incidence of infant death in the non-Aboriginal sample which limited the investigation of the impact of the specific aspects of maternal corrections history on infant mortality. Non-Aboriginal Infants whose mothers were imprisoned before or during pregnancy experienced higher prevalence of pregnancy risk factors than infants of mothers first imprisoned after birth.

7.2 Background

Women prisoners constitute a highly vulnerable population which is exposed to multiple and complex risk factors, including domestic violence, substance abuse, poverty, discrimination and mental illness, placing them and their children at risk of poor pregnancy and health outcomes.[1] However, few reports, exist which have investigated pregnancy outcomes for children of women prisoners.[2, 3] Of those studies that have investigated pregnancy outcomes for infants, the main outcomes investigated include preterm delivery and low birth weight.[3] The few studies that report on infant death have been limited by small numbers of events, in part due to the size of the cohort sampled.[3, 4]

While the international literature on the pregnancy outcomes of prisoners is equivocal, a review of studies from across the United States (US), United Kingdom and Europe found women imprisoned in pregnancy generally had poorer maternal and infant outcomes than community controls, and better outcomes than disadvantaged community controls.[3] It has been concluded that this may indicate that imprisonment in pregnancy may be beneficial for some pregnancy outcomes.[3] The only Australian study on pregnancy outcomes of women prisoners found, however, that women imprisoned during pregnancy did not have better perinatal outcomes than women imprisoned at times other than pregnancy.[4] Thus the unique context of the justice systems and prisoner populations in specific jurisdictions limit the transferability of findings across jurisdictions in the absence of an understanding of the determinants of pregnancy outcomes for women prisoners.

Studies in the US have found racial differences in the pregnancy outcomes of women prisoners.[5] In Australia, research on the pregnancy outcomes of Aboriginal women prisoners is lacking despite their overrepresentation in the prison population. In Western Australia, for example, Aboriginal peoples represent 4% of the general population but 46% of the female prison population.[6, 7] This reflects the high levels of social and economic disadvantage and discrimination experienced by Aboriginal peoples in Australia.[8] Similarly, Aboriginal peoples in Australia experience poorer pregnancy outcomes compared with non-Aboriginal mothers, and while infant mortality rates have been improving for both Aboriginal and non-Aboriginal populations across time, the racial disparity remains.[9, 10]

Across 1980 to 2001, infant mortality rates in Western Australia declined for both Aboriginal (25.0 in 1980-84 to 16.1 in 1998-2001) and non-Aboriginal infants (8.4 in 1980-84 to 3.7 in 1998-2001).[10] Some important changes that occurred across the past 30-years include improved transport for rural and remote pregnant women, immunization of infants, prevention of Sudden Infant Death Syndrome,[10] as well as increased parental employment and maternal education.[11] Although the overall rates of infant mortality declined between 1980 and 2001, the disparity between Aboriginal and non-Aboriginal populations increased from a Relative Risk of 3.0 (95%CI 2.5-3.6) in 1980-84 to 4.4 (95%CI 3.5-5.5) in 1998-2001.[10] For Aboriginal infants, postneonatal mortality was higher than neonatal mortality, a pattern that indicates the impact of socioeconomic disadvantage and marginalisation on infant mortality outcomes.[10]

The primary objective of this study was to explore determinants of infant mortality for Aboriginal and non-Aboriginal children, with a focus on whether maternal imprisonment during pregnancy is a risk factor for infant mortality. The specific aims of the study were to determine: infant mortality rates for Aboriginal and non-Aboriginal infants of mothers with different corrections histories; the key demographic and pregnancy-related risk factors which may contribute to infant mortality in Aboriginal and non-Aboriginal populations; the importance of maternal corrections history as a determinant of infant mortality after accounting for significant demographic and pregnancy-related risk factors; and the prevalence of key risk factors for infant mortality between infants with different maternal corrections histories.

7.3 Methods

7.3.1 Study design

We have used data from a large data linkage project to explore infant mortality within Aboriginal and non-Aboriginal children of mothers who have been exposed to the corrections system at different times in relation to their pregnancy. We compared infant mortality outcomes for children whose mothers had; (i) any period of imprisonment during pregnancy, (ii) imprisonment before (but not during) pregnancy, (iii) their first period of imprisonment after birth, (iv) community-based correctional orders (but no imprisonment), or (v) no corrections record at any time over the study period.

7.3.2 Conceptual framework

Mosley and Chen's[12] analytical framework for the study of child survival was adapted for the present study. The basis of this framework is that broader determinants necessarily act through biological pathways, or mechanisms, which impact before, during and after pregnancy on the healthy development of the fetus and infant, and ultimately on infant mortality. There is evidence that adverse events experienced before and during pregnancy can impact on fetal development and result in increased risk of poor infant and childhood health outcomes.[13-17]

Our adaptation of this framework first groups together key demographic factors, including birth year, sex, Aboriginal status, socioeconomic status, and geographical remoteness. The second grouping includes baseline pregnancy risk factors, such as multiple gestation, birth spacing <18 months, maternal age, and parity, which are largely unmodifiable from the commencement of pregnancy.[18] The third grouping includes key pregnancy complications that might be a precursor of infant mortality, such as nutritional deficiencies, placental disorders, prematurity, and infection.[19] The last group includes other maternal factors and exposures which are known risk factors for infant mortality or may indicate maternal vulnerability or household dysfunction, such as substance use or mental health related service contacts, external causes of injury, and having other children in contact with the child protection system.

7.3.3 Data sources

Data were obtained through the Western Australian Data Linkage System (WADLS). The WADLS uses highly-accurate computerised, probabilistic matching with clerical review to create linkages within and between administrative data collections across a range of Western Australian government agencies.[20] The Western Australian Data Linkage Branch conducted the linkage and provided de-identified data extracts. Records were extracted from the Midwives Notifications System, Birth Registrations, Death Registrations, Department of Justice, Hospital Morbidity Data System Collection (HMDC), Mental Health Information System (MHIS), and Department of Communities: Child Protection and Family Support (CPFS) data collections. These are all statutory State-wide data collections with complete coverage.

The Birth Registration and Midwives Notifications System data provided social and demographic characteristics of mothers and children at time of birth. Mortality data

include all deaths registered in Western Australia. The Department of Justice data collection includes all custodial records for offenders held in Western Australian prisons and records for offenders on community-based correctional orders. Data excluded unsentenced individuals detained in police stations and courts, immigration detention centres, and mental health facilities. The HMDC includes all inpatient records for Western Australian public and private hospitals and day surgeries. The MHIS includes presentations to all inpatient and public community mental health services. The CPFS data include all reports of concerns for child welfare made to the child protection system and the details of investigations, protection applications and orders as well as placements in out-of-home care.

The Death Registrations, HMDC, and MHIS use the International Classification of Diseases (ICD), to classify cause of death, diagnosis, or reason for health service contact, respectively. For HMDC records, we obtained one code for the principal diagnosis of the episode of care, and up to four codes for external causes of episodes of care. Over the study period, the ICD 9th Revision with Clinical Modification (ICD-9-CM)[21] related to services contacts before July 1999, and service contacts from that date used ICD 10th Revision with Australian Modification (ICD-10-AM)[22].

7.3.4 Study population

The study population was drawn from a retrospective longitudinal cohort study of all liveborn children born in Western Australia from 1985-2011 whose biological mother was imprisoned at least once within 18-years after their birth. The cohort study population included a comparison group of children whose mother had no record of imprisonment from their date of birth to their 18th birthday, which was identified through the same data sources as the cohort and matched 3:1 to cohort children on Aboriginal status, age and sex. Data on second-generation children, born between 1998 and 2014 to the female members of the cohort and comparison group, were also obtained.

Stillbirths (second-generation only) and infants with chromosomal abnormalities, identified through HMDC and death records, were excluded (Figure 7.1). Erroneous records with multiple mothers or missing key information such as birthdate were removed. The final study population was restricted to children born from October 1985

to June 2013 (inclusive) to ensure pregnancy exposure and death data was available for all infants.

In total, there were 42,674 infants in the final study population, 37,469 from the first-generation and 5,205 from the second-generation. Data from the birth and death registrations, midwives notifications records, and CPFS data were available for first- and second-generation children. Only first-generation children had HMDC record data. Mothers had corrections, HMDC, and MHIS data available.

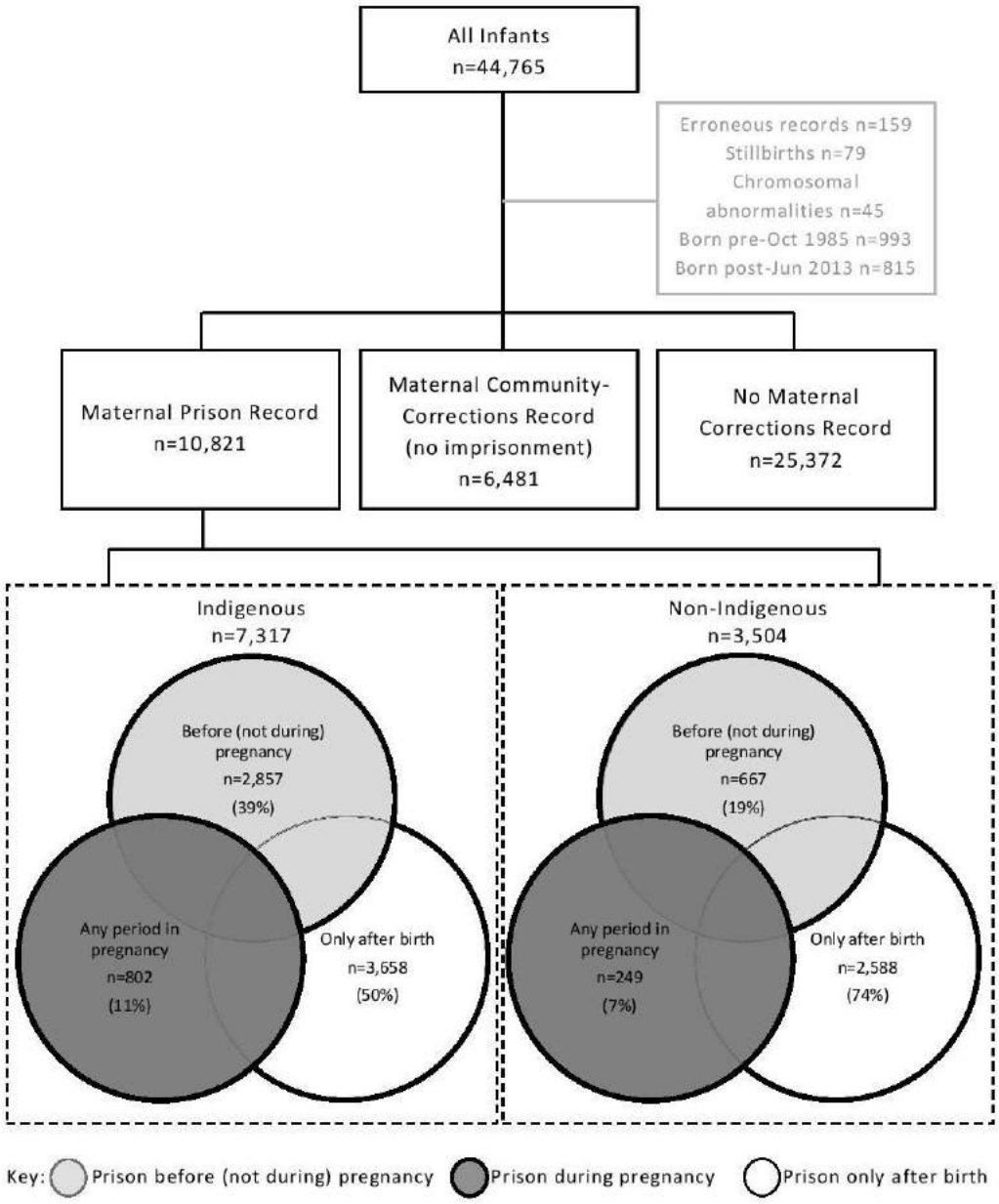


Figure 7.1 Selection of the study population and classification by maternal corrections history

Definition of maternal corrections history

The study population was categorised into: a) infants whose mothers had a record of imprisonment at any time (n=7,317 Aboriginal; n=3,504 non-Aboriginal); b) infants whose mothers had community-based correctional orders but no record of imprisonment (n=5,828 Aboriginal; n=653 non-Aboriginal); and c) infants whose mothers had no record within any Department of Justice database (n=12,817 Aboriginal; n=12,555 non-Aboriginal).

Imprisonment records covered prison stays of any length of time, and included unsentenced remandees detained before trial as well as sentenced prisoners. Infants of mothers who had a prison record at any time over the study period were further categorised based on the timing of their mother's imprisonment in relation to their pregnancy. The first group included infants whose mothers had any record of imprisonment during pregnancy. The second group included infants whose mothers had imprisonment records in the period before, but not during, pregnancy. The third group included infants whose mothers first record of imprisonment only occurred after the child's birth. These groupings are shown in Figure 7.1. Classifications were based on mother's prison reception dates and the infant's birth date.

Community-based sentences may involve treatment or vocational programs, community service, and place restrictions on offenders. Breach of conditions while on community orders may result in imprisonment. Accordingly, women with community-based correctional orders are sentenced offenders, but may differ to women given custodial prison sentences in terms of severity or frequency of their offending and other individual factors. They are not exposed to the prison environment which generally places more stringent conditions on offenders and has different implications for them and their families.

The proportion of infants in the various maternal corrections history sub-groups (Figure 7.1) relate only to the study sample and do not reflect the prevalence of these groups across the whole Western Australian population.

7.3.5 Pregnancy and birth dates

Child month and year of birth was provided by the Midwives Notification System, or if missing from the Birth Registration data. As gestational age was not available,

pregnancy start date was calculated as being nine months before the first day of the child's birth-month.

7.3.6 Definition of infant mortality

Infant mortality was defined as the death of a live born child under one year of age.[23] Full date of death was provided in the death registration data, however, birth data were available only for month and year of birth. Accordingly, infant mortality was defined as death within 12-full months after birth. For example, for a child born in January 2000, death on or before 31 January 2001 would be determined within the category of infant mortality.

7.3.7 Demographic characteristics

The Birth Registration and Midwives Notifications System data provides social and demographic characteristics of mothers and children at time of birth, including sex, socioeconomic status and geographical remoteness. Sex was taken primarily from Midwives Data, or if missing from Birth Data.

Area-based socio-economic status of infant's place of residence at time of birth was assigned using the Socio-economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage.[24] The smallest area of SEIFA reporting is Collectors District (CD) level, which is approximately 250 households or less in rural areas. Missing CD scores were imputed with mean CD-score by postcode before using broader area scores of SEFIA available for Statistical Local Area or Local Government Area.[25]

The Accessibility/Remoteness Index of Australia (ARIA)[26] was used to classify the geographical remoteness of infant's place of residence at time of birth. ARIA is derived from the measure of place of residence to populated locations and key services and classified as major cities, inner regional, outer regional, remote, and very remote locations. For the current study major cities and inner regional areas were combined given both have greater accessibility of relevant services[26].

Aboriginal status for infants and mothers in the study populations was ascertained from the Derived Indigenous Status Flag variable generated by the WADLS using best-practice algorithms, which assess individuals' Aboriginal status across multiple data collections to enhance accuracy.[27]

7.3.8 Baseline pregnancy factors

Maternal birth date was determined using all available data sources. Maternal age was calculated as the age of mother at time of birth. Birth date was available for all siblings which enabled parity and duration of birth spacing to be determined. Multiple gestation pregnancies were also derived based on siblings having shared birth dates or through maternal or child HDMC data. Child-level HDMC data were not obtained for the second-generation children, however, as stillbirths were captured for the second-generation this assisted in identifying multiple gestation pregnancies.

7.3.9 Pregnancy complications

The separate and combined effects of key pregnancy complications identified from maternal hospital records were evaluated. Pregnancy complications included the effects of infection-related hospitalisations, anaemia, diabetes, hypertension, preeclampsia, eclampsia, abruptio placentae, placenta previa, other placental disorders, premature rupture of membranes and renal disorders during pregnancy on infant mortality (Appendix F, Table F1).[19] Complications were excluded due to low incidence or non-significance ($p>0.05$), including hospitalisations for anaemia, diabetes, hypertension, preeclampsia, and eclampsia (Appendix F, Table F1).

7.3.10 Other maternal risk factors and exposures

Maternal substance use (including alcohol) and poisoning-related service contacts during pregnancy were identified from HMDC and MHIS data. Maternal hospital admissions for any injuries from external causes, excluding substance use, self-harm and poisoning-related contacts were identified during pregnancy. Maternal hospital admissions for mental and behavioural disorders, self-harm, and mental health service presentations, both excluding substance use and poisoning-related contacts, were identified during pregnancy from HMDC and MHIS data. Having an older sibling in contact with child protection services during the infant's pregnancy was also identified using sibling's child protection data.

7.3.11 Statistical analyses

All analyses were conducted using Stata Version 14.0. All analyses were stratified by Aboriginal status of the infants.

Infant mortality rates (per 1,000 population) were calculated for singleton infants by maternal corrections history. Prevalence of demographic and pregnancy-related risk factors were calculated for Aboriginal and non-Aboriginal populations. Log-binomial regression was used to calculate the Relative Risk of infant death for all univariate and multivariate analyses.

The strength of correlation between all variables of interest was assessed using Chi-square tests with Cramer's V statistic. For variable pairs with a medium effect size (>0.3),[28] one variable was excluded from further multivariate analysis on the basis of the univariate Relative Risk and level of statistical significance of each variable with infant mortality. Multivariate regression was then conducted for each grouping of variables (demographic factors, baseline pregnancy risk factors, pregnancy complications, and other maternal factors and exposures) separately with infant mortality, and variables that were not statistically significant ($p<0.05$) were excluded from further analysis (Appendix F, Table F2). All remaining variables were entered with maternal corrections history into a full regression model (Model 1). Variables were removed by key groups; other maternal factors and exposures (Model 2), pregnancy complications (Model 3), baseline pregnancy risk factors (Model 4), leaving the combined effects of maternal corrections history and demographic factors with infant mortality. Goodness-of-Fit was assessed from the Akaike Information Criterion (AIC) value. There were insufficient numbers of non-Aboriginal infant deaths whose mothers were imprisoned before or during pregnancy to undertake multivariate regression for non-Aboriginal children.

Prevalence of key demographic and pregnancy-related risk factors, as determined from the univariate and multivariate analyses, were calculated for each maternal corrections history grouping and by Aboriginal status.

7.4 Results

In total, 546 infants in the sample died aged 0 to 12 months, between October 1985 and June 2014. There was a 2.39-fold risk of infant mortality for Aboriginal infants compared to non-Aboriginal infants (95% CI: 1.95-2.93, $p<0.001$).

7.4.1 Infant mortality by maternal corrections history

For singleton births, Aboriginal infants whose mothers were imprisoned at any time had a significantly higher risk of death than infants of mothers with community corrections orders alone, or with no corrections history (Table 7.1). Aboriginal infants whose mothers were imprisoned during pregnancy had the highest rates of infant mortality (32.1 per 1000), compared to infants whose mothers were imprisoned either only before pregnancy (22.1 per 1000) or after birth (23.6 per 1000) (Table 7.1).

In non-Aboriginal infants, those whose mothers were imprisoned before (9.4 per 1000) or during (8.2 per 1000) pregnancy had apparently lower rates of infant mortality than those whose mothers were imprisoned for the first time after their birth (14.2 per 1000) or who had community orders alone (12.6 per 1000). This difference was not significant and confidence intervals wide, possibly due to the low numbers of infant deaths within the sample of non-Aboriginal children with mothers imprisoned before or during pregnancy.

7.4.2 Univariate analysis of infant mortality

As shown in Table 7.2, abruptio placentae and other placental disorders (excluding placenta previa) were associated with the highest risk of death for both Aboriginal and non-Aboriginal infants. Other important risk factors for Aboriginal and non-Aboriginal infants were low socioeconomic status, multiple gestation pregnancies, birth spacing <18-months, having an older sibling in contact with the child protection system during an infant's gestation, and maternal substance use or poisoning-related service contacts during pregnancy.

Maternal hospitalisations for premature rupture of membranes, or external causes of injury were important risk factors for infant mortality only for Aboriginal infants. Male sex was also only a risk factor for infants in the Aboriginal subgroup. Young maternal age and geographical location for those living in outer regional areas, were only significant risk factors in the non-Aboriginal sample.

Factors not strongly associated with infant death included parity, infection related hospitalisations, or mental health related service contact (not related to substance use) in pregnancy, and hospital admissions for placenta previa.

Table 7.1 Infant mortality for singleton births, by maternal corrections history and Aboriginal status

	Aboriginal infants, n=25371						Non-Aboriginal infants, n=16169					
	Survived	Died					Survived	Died				
	n	n	IMR[1]	RR	(95% CI)	*p*-value	n	n	IMR[1]	RR	(95% CI)	*p*-value
Maternal Corrections History												
Prison (before, not during, pregnancy)	2742	62	22.1	1.95	(1.45-2.62)	<.001	634	6	9.4	2.25	(0.97-5.22)	0.059
Prison (during pregnancy)	753	25	32.1	2.84	(1.87-4.31)	<.001	243	<5	8.2	1.96	(0.48-8.00)	0.349
Prison (after birth only)	3481	84	23.6	2.08	(1.59-2.72)	<.001	2491	36	14.2	3.42	(2.24-5.23)	<.001
Community corrections	5588	94	16.5	1.46	(1.13-1.89)	0.004	628	8	12.6	3.02	(1.44-6.33)	0.003
No corrections*	12400	142	11.3				12186	51	4.2			

Notes. Excludes multiples births (591 Aboriginal, 427 non-Aboriginal). [1]Infant mortality rate: deaths under 12 months, per 1000 live births.

Table 7.2 Risk factors for infant mortality, by Aboriginal status

		Aboriginal infants, n=25962						Non-Aboriginal infants, n=16712					
		Survived	Died					Survived	Died				
		n	n	%	RR	(95% CI)	*p*-value	n	n	%	RR	(95% CI)	*p*-value
	Infants	25532	430	1.7				16596	116	0.7			
Demographic Factors													
Sex[1]	Male	13052	240	1.8	1.20	(0.99-1.45)	0.058	8586	64	0.7	1.14	(0.79-1.65)	0.468
	Female*	12438	190	1.5				7991	52	0.6			
Maternal Aboriginal status	Aboriginal	24321	418	1.7	1.72	(0.97-3.05)	0.062						
	Non-Aboriginal*	1211	12	1.0				16596	116	0.7			
Socioeconomic status[2]	Very low (0-5%)	6793	128	1.8	2.16	(1.38-3.39)	0.001	996	15	1.5	3.50	(1.88-6.54)	<.001
	Low (6-25%)	11095	195	1.7	2.02	(1.30-3.13)	0.002	4461	50	1.1	2.62	(1.65-4.15)	<.001
	Medium (26-50%)	5054	83	1.6	1.89	(1.18-3.01)	0.008	4517	23	0.5	1.20	(0.69-2.07)	0.523
	High (51-100%)*	2546	22	0.9				6584	28	0.4			

		Aboriginal infants, cont.						Non-Aboriginal infants, cont.					
		Survived	Died					Survived	Died				
		n	n	%	RR	(95% CI)	*p*-value	n	n	%	RR	(95% CI)	*p*-value
Geographical remoteness[3]	Major cities/Inner regional*	10331	160	1.5				13574	88	0.6			
	Outer regional	4185	73	1.7	1.12	(0.85-1.48)	0.404	1811	22	1.2	1.86	(1.17-2.97)	0.009
	Remote	4776	75	1.5	1.01	(0.77-1.33)	0.922	834	5	0.6	0.93	(0.38-2.27)	0.865
	Very remote	6195	120	1.9	1.25	(0.98-1.58)	0.066	326	<5		0.47	(0.07-3.40)	0.458
Baseline Pregnancy Risk Factors													
Multiple gestation	Yes	568	23	3.9	2.43	(1.61-3.66)	<.001	414	13	3.0	4.81	(2.73-8.50)	<.001
	No*	24964	407	1.6				16182	103	0.6			
Birth spacing	<18months	3011	82	2.7	1.74	(1.37-2.21)	<.001	1112	19	1.7	2.70	(1.66-4.40)	<.001
	Firstborn/18months+*	22521	348	1.5				15484	97	0.6			
Maternal age	12-19 years	7628	122	1.6	0.91	(0.72-1.17)	0.471	1740	21	1.2	2.36	(1.41-3.94)	0.001
	20-24 years	9420	158	1.6	0.96	(0.76-1.20)	0.713	3916	47	1.2	2.35	(1.57-3.52)	<.001
	25-34 years*	7533	132	1.7				9054	46	0.5			
	35+years	951	18	1.9	1.08	(0.66-1.76)	0.761	1886	<5		0.21	(0.05-0.86)	0.030
Parity	Nulliparous	9035	126	1.4	0.82	(0.66-1.03)	0.093	7954	53	0.7	0.99	(0.67-1.45)	0.939
	Parity 1-2*	10847	184	1.7				7539	51	0.7			
	Parity 3+	5650	120	2.1	1.25	(0.99-1.57)	0.058	1103	12	1.1	1.60	(0.86-2.99)	0.140
Pregnancy Complications													
Abruptio placentae and other disorders[4]	Yes	122	8	6.2	3.77	(1.91-7.42)	<.001	90	<5		6.31	(2.38-16.8)	<.001
	No*	25410	422	1.6				16506	112	0.7			
Placenta previa	Yes	87	<5		2.02	(0.66-6.17)	0.217	109	0	0			
	No*	25445	427	1.7				16487	116	0.7			
Premature rupture of membranes	Yes	1200	34	2.8	1.72	(1.22-2.43)	0.002	445	5	1.1	1.63	(0.67-3.97)	0.284
	No*	24332	396	1.6				16151	111	0.7			
Infection related hospitalisation in pregnancy[5]	Yes	2041	34	1.6	0.99	(0.70-1.40)	0.947	388	<5		0.73	(0.18-2.96)	0.664
	No*	23491	396	1.7				16208	114	0.7			

		Aboriginal infants, cont.						Non-Aboriginal infants, cont.					
		Survived	Died					Survived	Died				
		n	n	%	RR	(95% CI)	*p*-value	n	n	%	RR	(95% CI)	*p*-value
Other Maternal Factors/Exposures in Pregnancy													
Substance use related service contact[6]	Yes	397	15	3.6	2.24	(1.35-3.72)	0.002	293	6	2.0	2.99	(1.33-6.76)	0.008
	No*	25135	415	1.6				16303	110	0.7			
Hospitalisation for external causes of injury[7]	Yes	1479	38	2.5	1.56	(1.12-2.17)	0.008	278	<5		1.55	(0.50-4.86)	0.450
	No*	24053	392	1.6				16318	113	0.7			
Mental health related service contact[8]	Yes	768	12	1.5	0.93	(0.52-1.64)	0.794	427	5	1.2	1.70	(0.70-4.14)	0.244
	No*	24764	418	1.7				16169	111	0.7			
Sibling in contact with child protection[9]	Yes	852	30	3.4	2.13	(1.48-3.07)	<.001	237	6	2.5	3.70	(1.64-8.33)	0.002
	Firstborn/No*	24680	400	1.6				16359	110	0.7			

*** Reference category**
1 42 Aboriginal and 19 non-Aboriginal infants missing sex
2 46 Aboriginal and 38 non-Aboriginal infants missing socioeconomic status
3 47 Aboriginal and 51 non-Aboriginal infants missing remoteness
4 Excludes placenta previa
5 Infection related hospitalisation in pregnancy
6 Substance use (including alcohol) or poisoning related service contact (hospital or mental health service)
7 Hospitalisation for external causes of injury in pregnancy (excludes poisoning)
8 Mental health service contact in pregnancy (excludes substance use) (hospital or mental health service)
9 Older sibling(s) in contact with child protection system in infant's pregnancy

7.4.3 Multivariate regression of infant mortality for Aboriginal infants

Multivariate regression was only performed for Aboriginal children because of the low number of deaths in the sample of non-Aboriginal infants with incarcerated mothers.

Variables for maternal Aboriginal status, geographical remoteness, maternal age, parity, placenta previa, infection-related hospitalisations, external injury-related hospitalisations, and mental health related service contacts in pregnancy (other than for substance use) were excluded based on their lack of association with infant mortality in our data (Appendix F, Table F2). The remaining variables were included and are shown in Model 1 (Table 7.3). In Models 2-4, variables were removed by group in order of; other maternal factors and exposures (Model 2), pregnancy complications (Model 3), baseline pregnancy risk factors (Model 4), leaving the combined effects of maternal corrections history and demographic factors on infant mortality in Model 4.

The best model fit was achieved with the inclusion of all variables (i.e., Model 1). Abruptio placentae and other placental disorders contributed the highest risk of infant death, followed by maternal imprisonment during pregnancy, and multiple gestation pregnancy. The effect of birth year remained stable across Models 1-4 and approximated to a 4% reduction in risk of infant mortality each year.

Table 7.3 Regression model of infant mortality, Aboriginal children

		Model 1			Model 2			Model 3			Model 4		
		RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value
Maternal Corrections History	Prison (before pregnancy)	1.83	(1.36-2.47)	<.001	1.99	(1.49-2.67)	<.001	2.03	(1.51-2.71)	<.001	2.10	(1.57-2.81)	<.001
	Prison (during pregnancy)	2.55	(1.69-3.86)	<.001	2.96	(1.98-4.43)	<.001	3.01	(2.01-4.51)	<.001	3.10	(2.07-4.64)	<.001
	Prison (after birth)	1.55	(1.18-2.03)	0.001	1.64	(1.25-2.14)	<.001	1.67	(1.28-2.18)	<.001	1.73	(1.32-2.25)	<.001
	Community-only	1.38	(1.07-1.77)	0.012	1.41	(1.10-1.81)	0.007	1.42	(1.11-1.83)	0.006	1.45	(1.13-1.87)	0.003
	No corrections history	ref.											
Demographic Factors													
Birth year		0.96	(0.95-0.97)	<.001	0.96	(0.95-0.98)	<.001	0.96	(0.95-0.98)	<.001	0.97	(0.95-0.98)	<.001
Sex	Male	1.21	(1.01-1.47)	0.044	1.22	(1.01-1.47)	0.039	1.22	(1.01-1.47)	0.038	1.22	(1.01-1.48)	0.036
	Female	ref.											
Socioeconomic status	Very low (0-5%)	2.11	(1.35-3.31)	0.001	2.08	(1.33-3.27)	0.001	2.1	(1.34-3.30)	0.001	2.11	(1.34-3.31)	0.001
	Low (6-25%)	1.88	(1.21-2.91)	0.005	1.86	(1.20-2.88)	0.006	1.87	(1.20-2.89)	0.005	1.91	(1.23-2.96)	0.004
	Medium (26-50%)	1.75	(1.10-2.80)	0.018	1.74	(1.09-2.78)	0.02	1.75	(1.10-2.79)	0.019	1.78	(1.11-2.83)	0.016
	High (51-100%)	ref.											
Baseline Pregnancy Risk Factors													
Multiple gestation	Yes	2.29	(1.51-3.46)	<.001	2.37	(1.57-3.59)	<.001	2.58	(1.71-3.88)	<.001			
	No	ref.											
Birth spacing	<18months	1.52	(1.19-1.93)	0.001	1.57	(1.24-2.00)	<.001	1.60	(1.26-2.03)	<.001			
	Firstborn/18months+	ref.											
Pregnancy Complications													
Abruptio placentae, etc.[1]	Yes	2.85	(1.46-5.59)	0.002	2.92	(1.49-5.72)	0.002						
	No	ref.											
PROM[2]	Yes	1.66	(1.18-2.35)	0.004	1.67	(1.18-2.37)	0.003						
	No	ref.											
Other Maternal Factors/Exposures in Pregnancy													
Substance use related contact	Yes	1.71	(1.02-2.87)	0.042									
	No	ref.											
Injury related hospitalisation	Yes	1.20	(0.86-1.68)	0.283									
	No	ref.											
Sibling Child Protection	Yes	1.57	(1.07-2.31)	0.022									
	Firstborn/No	ref.											

	Model 1			Model 2			Model 3			Model 4		
	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value
Observations	25,875			25,875			25,875			265,875		
AIC	0.1640			0.1642			0.1646			0.1656		

Note. [1]Includes 'other placental disorders', excludes placenta previa. [2]Premature rupture of membranes.

7.4.4 Prevalence of key demographic and pregnancy risk factors by maternal corrections history

Table 7.4 shows the prevalence of pregnancy risk factors selected from the previous univariate and multivariate analyses, for Aboriginal and non-Aboriginal infants reported by their mothers' contact with corrective services.

Infants of mothers with any corrections history had, in most instances, higher prevalence of maternal service contact in pregnancy for substance use (including poisoning), external causes of injury, mental health related service contacts, and sibling contact with the child protection system compared to infants whose mothers had no record with corrective services. Prevalence of these service contacts in pregnancy was highest for infants whose mothers were imprisoned during pregnancy, and higher for infants whose mothers were imprisoned before pregnancy compared to those imprisoned for the first time after birth or who had community corrections orders for these service contacts.

The proportion of infants born in areas of very low socioeconomic status was high for all groups of Aboriginal children (>20%) and did not differ by maternal corrections history. There was a higher proportion of low socioeconomic status for non-Aboriginal children with any maternal corrections record (12-13%) compared to those with no maternal corrections history (4%).

There was a higher prevalence of a birth spacing of less than 18-months for infants with any maternal corrections record compared to no maternal corrections history, except the difference was not significant for those infants whose mothers were imprisoned during pregnancy. The prevalence of infants born to mothers aged less than 20 years was highest among infants whose mothers were first imprisoned after birth or had community-corrections orders.

For Aboriginal children, maternal hospitalisation for abruptio placentae and other placental disorders (excluding placenta previa) was not different between infants by maternal corrections history, whereas prevalence of maternal hospitalisation for premature rupture of membranes was higher where there had been any record of maternal contact with the corrections system.

Table 7.4 Prevalence of pregnancy risk factors for infant mortality, by maternal corrections exposure and Aboriginal status

	Aboriginal infants					Non-Aboriginal infants				
	Prison (before preg.) n=2857	Prison (during preg.) n=802	Prison (after birth) n=3658	Comm-unity n=5828	No Correct-ions n=12817	Prison (before preg.) n=667	Prison (during preg.) n=249	Prison (after birth) n=2588	Comm-unity n=653	No Correct-ions n=12555
Very low SES[1]										
%	22.9	22.7	29.1	29.8	25.7	13.3	13.4	12.8	12.3	3.8
RR	0.89	0.88	1.13	1.16	ref.	3.48	3.49	3.35	3.20	ref.
p-value	0.002	0.057	<.001	<.001		<.001	<.001	<.001	<.001	
Multiple gestation										
%	1.9	3.0	2.5	2.5	2.1	4.0	1.6	2.4	2.6	2.5
RR	0.86	1.39	1.18	1.17	ref.	1.60	0.63	0.93	1.03	ref.
p-value	0.328	0.113	0.152	0.126		0.017	0.362	0.602	0.911	
Birth spacing <18mth										
%	17.9	11.2	14.1	12.8	9.6	12.7	8.0	9.8	10.4	5.6
RR	1.87	1.17	1.47	1.34	ref.	2.27	1.43	1.75	1.86	ref.
p-value	<.001	0.127	<.001	<.001		<.001	0.099	<.001	<.001	
Maternal age <20yrs										
%	15.3	28.6	41.7	33.1	28.3	9.3	10	25.9	26	6.6
RR	0.54	1.01	1.47	1.17	ref.	1.40	1.51	3.91	3.92	ref.
p-value	<.001	0.895	<.001	<.001		0.007	0.032	<.001	<.001	
Placental disorders[2]										
%	0.5	0.7	0.6	0.7	0.4	0.1	0.8	1.1	1.1	0.4
RR	1.17	1.92	1.54	1.72	ref.	0.34	1.83	2.56	2.45	ref.
p-value	0.620	0.130	0.090	0.011		0.288	0.398	<.001	0.025	
PROM[3]										
%	6.8	5.5	5.1	5.2	4.0	5.5	3.2	3.7	3.2	2.3
RR	1.71	1.39	1.28	1.32	ref.	2.41	1.4	1.59	1.40	ref.
p-value	<.001	0.032	0.003	<.001		<.001	0.344	<.001	0.133	
Substance use[4]										
%	3.2	7.4	2.2	1.6	0.7	12.3	10.0	4.7	3.2	0.4
RR	4.64	10.59	3.15	2.27	ref.	30.87	25.21	11.74	8.08	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	
External injury[5]										
%	10.9	14.5	9.4	6.5	2.9	6.9	6.4	3.4	2.1	0.9
RR	3.78	5.02	3.26	2.25	ref.	7.46	6.95	3.72	2.32	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	0.003	
Mental health[6]										
%	6.7	8.4	3.6	3.1	1.6	13.5	10.8	5.0	5.1	1.2
RR	4.20	5.22	2.27	1.96	ref.	11.15	8.96	4.15	4.17	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	
Sibling in contact CP[7]										
%	11.6	14.3	5.2	2.6	0.7	12.9	11.2	4.4	1.5	0.05
RR	15.68	19.35	6.97	3.50	ref.	269.80	235.30	91.36	32.04	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	

1 46 Aboriginal and 38 non-Aboriginal infants missing socioeconomic status
2 Excludes placenta previa
3 Premature rupture of membranes
4 Substance use (including alcohol) or poisoning related service contact (Mental Health or Hospital)
5 Hospitalisation for external causes of injury in pregnancy (excludes poisoning)

6 Mental health related service contact in pregnancy (excludes substance use) (Mental Health or Hospital)
7 Older sibling(s) in contact with child protection system in infant's pregnancy

For the non-Aboriginal children, hospitalisation of the mother for abruptio placentae and other placental disorders (excluding placenta previa) was higher where infants' mothers were first imprisoned after birth or had community-correctional orders, and prevalence of hospitalisation for premature rupture of membranes was higher where infants' mothers were imprisoned before or after pregnancy.

7.5 Discussion

This is the first study to provide a comprehensive investigation of infant mortality outcomes for children of women prisoners. Children of mothers with a history of contact with corrective services, including community-based corrections orders and imprisonment before or after pregnancy, had increased rates of infant mortality.

Within the Aboriginal sample, rates of infant mortality were highest for infants whose mothers were imprisoned during pregnancy, when compared to similarly disadvantaged mothers who were imprisoned at times other than pregnancy or who had community-based correctional orders. The strength of the relationship between infant mortality and maternal imprisonment in pregnancy for Aboriginal infants remained in the full model after adjusting for other important risk factors. The only determinant to have a greater association with Aboriginal infant mortality was abruptio placentae and other placental disorders, a serious pregnancy complication. Imprisonment during pregnancy was a stronger determinant of infant mortality than all other pregnancy complications and baseline pregnancy risk factors including multiple gestation pregnancies. Aboriginal infants whose mothers were imprisoned during pregnancy also experienced the highest prevalence of maternal contact with services during pregnancy for substance use, mental illness, and external injury. These findings clearly demonstrate the significant vulnerability of Aboriginal infants whose mothers are imprisoned during pregnancy.

It was not possible to determine the relationship between maternal imprisonment before and during pregnancy and the risk of infant mortality for non-Aboriginal infants due to the relatively small numbers of infants in the sample populations whose mothers were imprisoned before or during pregnancy. However, non-Aboriginal infants whose mothers who were imprisoned before or during pregnancy had a significantly higher prevalence of several pregnancy risk factors including maternal service contact in

pregnancy for substance use, external injury, or mental health issues, and having siblings in contact with the child protection system, compared to non-Aboriginal infants whose mothers were first imprisoned after birth or had community-based corrections orders alone.

Infant mortality is a marker of adversity which is strongly linked to social and economic disadvantage.[10] It is well-established that Aboriginal children experience higher rates of socioeconomic disadvantage and infant mortality than non-Aboriginal children.[10, 29] Over a quarter of our Aboriginal subgroup, compared to only 6% of the non-Aboriginal sample, was born in the lowest 5% of areas by socioeconomic status. Socioeconomic disadvantage provides a broad measure of social determinants such as parental education, employment, disability, and overcrowding as well as a greater prevalence of health conditions and risk behaviours such as alcohol and substance use, domestic violence, and mental illness, which are related to infant mortality risk. For Aboriginal peoples, socioeconomic disadvantage is also associated with experiences of racism and discrimination in service access and broader society, and in increased contact with health and criminal justice systems.[30]

It is recognised that imprisonment likely acts as both a proxy for socioeconomic disadvantage and for risk behaviours which are associated with imprisonment, including increased substance use, injury and mental illness, as evidenced in our study by increased prevalence of service contacts related to these risks in pregnancy for pregnant prisoners. Similarly, having a sibling in contact with the child protection system during pregnancy can be considered as a proxy for maternal vulnerability and socioeconomic disadvantage. Whether maternal imprisonment during pregnancy has an impact on birth outcomes, including infant mortality, over-and-above the effects of pre-existing disadvantage, is a key issue within the international literature.[3]

It has been proposed that there may be a possible protective effect of imprisonment in pregnancy for birth outcomes.[3] The proposed protective effect of imprisonment in pregnancy on birth outcomes is thought to be contributed to by a reduction of exposure to risk factors such as domestic violence and substance use while in custody, and in improved nutrition and access to antenatal care. Within our study, infants whose mothers were imprisoned before pregnancy had a higher prevalence of risk factors during pregnancy related to maternal service contact for substance use, injury, and

mental illness, when compared to infants whose mothers were first imprisoned after birth. This finding suggests that risk behaviours of this kind do occur concurrently with imprisonment. However, the strength of our findings with respect to maternal imprisonment during pregnancy for Aboriginal infants suggest there may be an additional impact of imprisonment during pregnancy on infant mortality risk, at least in certain circumstances.

Similar to our findings, the general protective effect of imprisonment during pregnancy on birth outcomes that has been reported in the broader international literature was not replicated in the only prior Australian study of the effects of maternal imprisonment on pregnancy outcomes.[4] While just over one-quarter of pregnant prisoners were Aboriginal, Walker and colleagues[4] did not investigate the outcomes for the Aboriginal and non-Aboriginal populations separately. Our study has clearly demonstrated that infant mortality is higher for Western Australian Aboriginal infants whose mothers were imprisoned during pregnancy. Taken together, our study and that of Walker and colleagues[4] suggest that there are different outcomes for the infants of Australian women imprisoned during pregnancy than those reported for other jurisdictions.[3] It is not yet clear, however, whether this difference is restricted to the Aboriginal population as our findings were inconclusive, due to small numbers, with respect to non-Aboriginal infants.

The difference in outcomes for Australian pregnant prisoners compared to those within other criminal justice systems reported in the international literature,[3] may relate to the longer periods of imprisonment experienced by women in other jurisdictions compared to Australia, as an increased length of imprisonment in pregnancy is associated with higher birth weight which represents a positive pregnancy outcome.[31, 32] For example, Walker and colleagues[4] reported the average length of stay for sentenced women prisoners in New South Wales, Australia, is 196 days compared to 547 days in US prisons.[4] In our study of Western Australian children exposed to maternal incarceration before their second birthday, almost half of all prison stays for either sentenced prisoners or unsentenced remandees were <2 weeks.[33] In this context the presumption that imprisonment has a 'dose-response' effect on perinatal outcomes,[32] and that short-term imprisonment does not carry excess risks for the mother or her infant warrants further research.

Within Western Australia, all pregnant prisoners are provided with health care "commensurate with community standards".[34] However, health service provision varies between prisons,[35-40] and regional prisons face additional challenges such as in the transportation of prisoners to community health centres.[41] There is limited evidence available on the provision and impact of antenatal care provided to pregnant prisoners in Australia. In New South Wales, Walker and colleagues[4] found that women imprisoned during pregnancy were more likely to initiate antenatal care after 20 weeks gestation than women with no record of imprisonment. However as many of these women were not imprisoned for the duration of pregnancy, as was the case for women in the present study, it is possible antenatal care was first initiated during imprisonment.

Imprisonment during pregnancy may have negative impacts on the mental health and wellbeing of women, particularly for Aboriginal mothers, as a consequence of being separated from family and country during their pregnancy.[42] There is evidence that maternal stress in pregnancy can impact on birth outcomes.[43, 44] Research on offender health has demonstrated that the year following release from prison, particularly within the first month of release, is also a key risk period for an offender's own hospitalisation and mortality.[45-48] Whether the release period also leads to increased risk for offenders' children, including the unborn children of pregnant prisoners, has not been investigated. The results from the present study highlight that this as an important area of future research.

Further research is needed to understand whether there are particular characteristics of maternal imprisonment during pregnancy that are associated with infant mortality, and whether the effect is restricted to Aboriginal populations. The study findings highlight the importance of separate consideration of Aboriginal populations when investigating outcomes for children of prisoners, as combining populations may mask important differences in outcomes.

7.5.1 Limitations

These results need to be considered within the context of the study's limitations, for example, the power to detect relationships between infant mortality and maternal imprisonment before or during pregnancy in the non-Aboriginal sample was limited by the small numbers of non-Aboriginal infant deaths reported within those groups.

As gestational age was not available, pregnancy was taken to begin nine-months prior to month of birth for all infants. Accordingly, some records of exposure to maternal imprisonment, and service contacts related to substance use, mental health or child protection, that were attributed to having occurred during pregnancy may have occurred prior to pregnancy if gestation was shorter than nine-months. There is evidence, however, that adverse events within the preconception period (6-0 months before pregnancy) can increase infant mortality risk.[49, 50] Therefore any records of exposure misclassified as having occurred during pregnancy, may still have been expected to have an impact on infant mortality risk.

Additionally, without gestational age we have not been able to measure preterm birth (delivery before 37 weeks of gestation), which is associated with infant mortality.[51] However, preterm birth shares many of the same risk factors for infant mortality identified within the study including low socioeconomic status, maternal age, maternal stress, infections, and multiple gestation pregnancies.[51] The study has provided the first evidence of an association between maternal incarceration in pregnancy and infant mortality, further research is need to investigate the impact of factors not able to be measured in the current study, notably preterm birth, antenatal care and caesarean section rates.

Administrative data alone cannot fully capture occurrences of heavy drinking or substance use, mental illness, or injuries resulting from domestic violence, within pregnancy.[52] In addition, the study only obtained the primary diagnosis code (not co-diagnoses) for hospital and mental health service records. Consequently, the associations observed in our study with drinking or other substance use in pregnancy, mental illness or injuries are likely under ascertained.

Hospital data were not obtained for second-generation children. While explanatory variables based on hospital data were primarily taken from maternal hospital records (available for all mothers), there may have been some missed cases of chromosomal abnormalities, and substance use related service contacts in pregnancy, for the second-generation children.

7.6 Conclusions

To date there have been few studies which have focussed on the impact of maternal imprisonment on infant mortality. This study provides the first detailed analysis of infant mortality outcomes for children whose mothers were imprisoned in pregnancy. The study demonstrates that there are higher rates of infant mortality for Aboriginal, compared to non-Aboriginal, children of prisoners and that within the Aboriginal sample any maternal contact with the corrections system is associated with an increase in infant mortality.

Maternal imprisonment in pregnancy is an important determinant of infant mortality for Aboriginal children. Further research is needed to determine what factors contribute to this increased risk of infant mortality, and whether particular groups of prisoners are more affected. Due to the relatively low incidence of infant deaths within the non-Aboriginal sample, it was not possible to determine the impact of maternal imprisonment on infant mortality in this sub-population. It was the case, however, that non-Aboriginal infants whose mothers were imprisoned before or during pregnancy experienced higher rates of pregnancy risk factors, than infants whose mothers were first imprisoned after birth or had community-based correctional orders. This highlights the vulnerability of non-Aboriginal and Aboriginal pregnant prisoners, and the importance of providing support services to address pregnancy risk factors for women in contact with the corrections system.

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8 Study IV
Determinants of Low Birth Weight for Children of Women Prisoners

The following study addresses Research Aims 2 and 4 by comparing rates of low birth weight between children of women prisoners and children in the general community, and establishing whether maternal imprisonment during pregnancy is a determinant of low birth weight.

The associated manuscript titled: 'Low birth weight and maternal incarceration in pregnancy: A longitudinal linked data study of Western Australian infants', is currently under review.

8.1 Abstract

Rationale

Improved birth weight outcomes have been reported for infants of mothers imprisoned during pregnancy relative to similarly disadvantaged mothers, however, findings are equivocal and evidence is lacking from jurisdictions outside the United States.

Objective

To investigate whether maternal imprisonment during pregnancy is a determinant of low birth weight (<2500g) for Aboriginal and non-Aboriginal infants in Western Australia.

Methods

A longitudinal sample of 41,910 singleton infants born in Western Australia from October 1985 to December 2013, was identified with linked administrative data and examined by five mutually exclusive categories of maternal corrections history; (i) imprisonment in pregnancy, (ii) imprisonment before pregnancy, (iii) first imprisonment after birth, (iv) community-based corrections record without imprisonment at any time, and (v) no corrections record at any time. Univariate and multivariate Poisson regression was performed to determine key risk factors for low birth weight. Prevalence of risk factors were calculated by maternal corrections history.

Results

After adjusting for other significant pregnancy risks, maternal imprisonment before (Aboriginal RR 2.02, 95%CI 1.84-2.22, p<.001; non-Aboriginal RR 2.48, 95%CI 1.98-3.12, p<.001) or during (Aboriginal RR 1.96, 95%CI 1.68-2.29, p<.001; non-Aboriginal RR 2.12, 95%CI 1.48-3.03, p<.001) pregnancy remained strong determinants of low birth weight, and carried greater risk than imprisonment after birth (Aboriginal RR 1.58, 95%CI 1.44-1.74, p<.001; non-Aboriginal RR 1.75, 95%CI 1.51-2.04, p<.001) or community-based corrections orders (Aboriginal RR 1.32, 95%CI 1.21-1.43, p<.001; non-Aboriginal RR 1.40, 95%CI 1.05-1.88, p<.001), relative to no corrections record. Pregnancy risk factors that were more prevalent amongst infants whose mothers were imprisoned before or during pregnancy included substance-use related service contacts, hospitalisation for injury, mental health service contacts, and having a sibling in contact with the child protection system.

Conclusions

Western Australian infants with mothers imprisoned before or during pregnancy experience elevated risk of low birth weight and exposure to maternal substance use, injury and mental distress in pregnancy.

8.2 Introduction

The high level of disadvantage within the women prisoner population is well documented. Women prisoners experience elevated levels of adversity including intimate partner violence, mental health disorders, alcohol and other substance misuse, unemployment, and insecure housing.[1] There are, however, comparatively few studies on the perinatal outcomes of women prisoners.[2-4]

Birth weight is an important perinatal outcome, with low birth weight potentially representing the product of a suboptimal intrauterine environment.[2] A birth weight of less than 2500g is associated with an increased risk of infant mortality, and of developing health problems in later life including cardiovascular problems and diabetes.[5-11]

Three systematic reviews[2-4] have identified five studies,[12-16] all conducted within the United States, that have compared low birth weight outcomes for infants of mothers imprisoned during pregnancy to disadvantaged and/or general population controls. Together these studies have generally found a reduction in low birth weight for infants whose mothers were imprisoned during pregnancy, compared to similarly disadvantaged controls, suggesting imprisonment may have a beneficial, rather than detrimental effect on perinatal outcomes.[2] It has been postulated that maternal imprisonment may improve infant birth weight outcomes through increased access to antenatal care, better nutrition, and reduced exposure to alcohol, drugs and intimate partner violence.[12, 13] In contrast, the only Australian study to investigate the impact of maternal imprisonment on birth weight did not find a beneficial association between maternal imprisonment and birth weight.[17] It is not clear whether maternal imprisonment has a direct impact on perinatal outcomes, or whether such outcomes are predominantly a consequence of the high level of socioeconomic disadvantage and other adversity experienced by the prisoner population.

In Australia, there is a wide disparity in health and social outcomes for Aboriginal and Torres Strait Islander people, hereafter Aboriginal people, resulting from the impacts of colonisation, including land dispossession, forced removal of children from families, and continuing discriminatory policies, practices, and societal attitudes.[18] Despite some improvement, Aboriginal infants remain more likely to be born of low birth weight and experience higher rates of chronic disease and shorter life expectancy than non-

Aboriginal children. Aboriginal women are also overrepresented in the prison population. In Western Australia, for example, Aboriginal people represent 4% of the general population and 46% of the female prison population.[19, 20] It is therefore important to understand whether maternal imprisonment is a risk factor for poor perinatal outcomes for Aboriginal infants.

8.2.1 Objectives

The primary objective of this study was to determine whether maternal imprisonment during pregnancy is a risk factor for low birth weight for Aboriginal and non-Aboriginal children.

The specific aims of the study were to determine: (i) the prevalence of low birth weight for Aboriginal and non-Aboriginal infants of mothers with different corrections histories; (ii) key social, demographic and pregnancy-related risk factors (identifiable from health-related administrative datasets), which may contribute to low birth weight in Aboriginal and non-Aboriginal populations; (iii) the importance of maternal corrections history as a determinant of low birth weight after accounting for significant social, demographic and pregnancy-related risk factors; and (iv) the prevalence of significant risk factors for low birth weight between infants with different maternal corrections histories.

8.3 Methods

8.3.1 Study design and sampling

In the present study we have used data from a large data linkage project to explore determinants of low birth weight within Aboriginal and non-Aboriginal children of mothers who had been exposed to the corrections system at different times in relation to their pregnancy. We compared the outcomes for infants whose mothers were imprisoned during pregnancy, to groups of infants whose mothers had a history of imprisonment at a time other than during pregnancy, were just exposed to community-based correctional orders, or with no history of contact with corrective services.

The study population was derived from a longitudinal cohort study of all Western Australian children born from 1985 to 2011 whose biological mother was imprisoned within 18-years of their birth, with a randomly sampled comparison group of children

whose mothers had no imprisonment record within 18-years after their birth. Three comparison children were sampled for each cohort children and matched on Aboriginal status, age and sex. All cohort and comparison group children were liveborn. Data were also obtained on the second-generation children born from 1998 to 2014 to the female members of the cohort and comparison group.

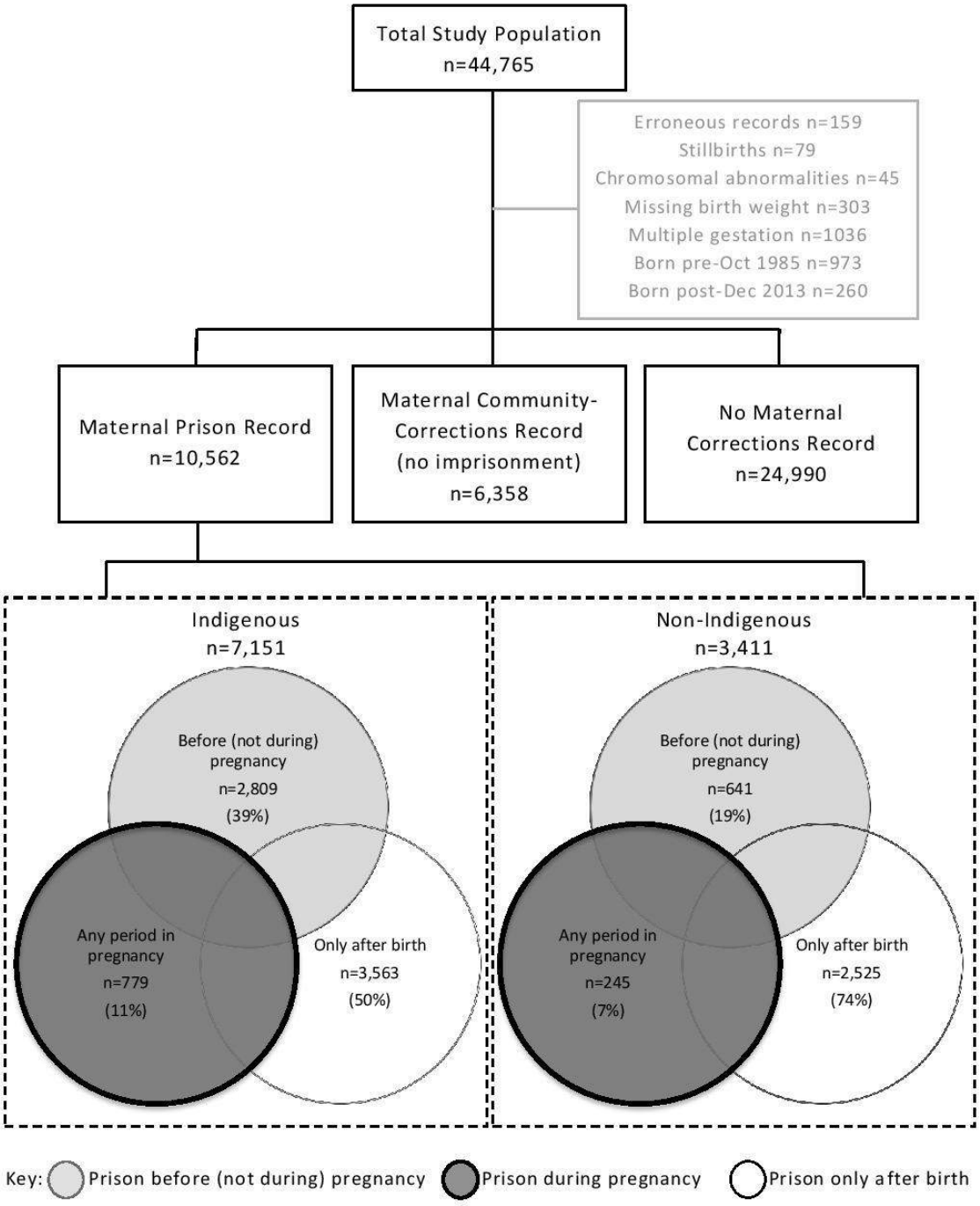


Figure 8.1 Selection of the study population and classification by maternal corrections history

All children with available data, including second-generation children, were included in the total study population (Figure 8.1). Children were excluded from the study population if they were stillborn (second-generation only), a multiple gestation pregnancy (twins, triplets, etc.), or diagnosed with a chromosomal abnormality. The study population was limited to children born between October 1985 and December 2013 to ensure nine months of pregnancy data was available for all individuals. In total, there were 41,910 infants in the final study population including 36,557 from the first-generation and 5,353 from the second-generation.

The proportion of infants in the various maternal corrections history sub-groups (shown in Figure 8.1), relate only to the study population and do not reflect the prevalence of these groups across the whole Western Australian population.

8.3.2 Data sources

The Western Australian Data Linkage Branch (WADLB) identified the study population, conducted the data linkage and provided de-identified data extracts to the project researchers through the Western Australian Data Linkage System (WADLS). The WADLS uses highly accurate computerised, probabilistic matching with clerical review to create linkages between administrative data collections across a range of Western Australian government departments and services.[21]

Table 8.1 outlines the data collections utilised for the present study. These are all statutory State-wide data collections with good coverage of the Western Australian population. Data on birth registrations, midwives records, and child protection system contacts were obtained for all first-and second-generation children. Hospital data was only obtained for first-generation children. Corrections, hospital, and mental health data was obtained for all mothers.

The Hospital Morbidity Data Collection (HMDC) and Mental Health Information (MHIS) data collections use the International Statistical Classification of Diseases (ICD) (ICD-9-CM[22] to June 1999, ICD-10-AM[23] from July 1999), to classify diagnosis, or reason for health service contact. For hospital records, the principal diagnosis code and up to four codes for external causes of injury, were obtained.

Aboriginal status for children and mothers was provided through the Derived Indigenous Status Flag variable generated by the WADLS using best-practice

algorithms, which assess individuals' Aboriginal status across numerous data collections to increase accuracy.[24]

Table 8.1 Brief description of data sources

Data Collection	Data Coverage
Midwives Notifications System (MNS)	Notifications for all births attended by a midwife where the gestational age is at least 20 weeks or infant weight 400g+ if gestation unknown
Birth Registrations	All births registered in Western Australia
Department of Justice	All records of adult and juvenile offenders detained in Western Australian prisons, and under departmental supervision on community-based orders
Hospital Morbidity Data Collection (HMDC)	All inpatient records for Western Australian public and private acute and psychiatric hospitals
Mental Health Information System (MHIS)	All presentations to public community mental health services
Department of Communities: Child Protection and Family Support	All reports of concern for child welfare, investigations, protection applications and orders, and placements in out-of-home care

8.3.3 Definition of maternal corrections history

The total study population was subdivided based on maternal corrections records (Figure 8.1), including infants whose mothers had: a prison record at any time (n=7,151 Aboriginal; n=3,411 non-Aboriginal); community-based correctional orders but no prison record (n=5,716 Aboriginal; n=642 non-Aboriginal); and no corrections record (n=12,677 Aboriginal; n=12,313 non-Aboriginal).

Women with community-based correctional orders are sentenced offenders, but may differ to women given custodial prison sentences based on the severity or frequency of their offending and other individual factors. Community-based sentences may involve treatment or vocational programs, community service, and place restrictions on offenders.

Imprisonment records were for prison stays of any length of time, and included unsentenced remandees detained before trial as well as sentenced prisoners. Infants of mothers who had a prison record at any time over the study period were further subdivided so as to explore the effect of timing of maternal imprisonment on infant birth weight. The first group included infants whose mothers had any record of

imprisonment during pregnancy. The second group included infants whose mothers had imprisonment records any time before, but not during, pregnancy. The third group included infants whose mothers first record of imprisonment only occurred after their birth. These main groupings are summarised in Figure 8.1 and were based on mother's prison reception date and the infant's birth date.

8.3.4 Definition of low birth weight

Following the World Health Organization (WHO) definition, children in the study population with a birth weight less than 2500g were classified as being 'low birth weight'.[25]

8.3.5 Pregnancy and birth dates

Child month and year of birth was provided by the Midwives Notification System (MNS), or if missing from the Birth Registration data. As gestational age was not obtained, pregnancy start date was calculated as being nine months before the first day of the child's birth-month.

8.3.6 Conceptual framework

The Mosley and Chen[26] framework for the study of child survival was used to identify other important pregnancy risk factors from the available study data. The basis of the framework is that broader determinants necessarily operate through biological pathways or mechanisms, to impact on the healthy development of the fetus. Our adaptation includes four key groups: demographic factors; baseline pregnancy risk factors, which are largely unmodifiable from the commencement of pregnancy; pregnancy complications, that are precursors to poor perinatal outcomes; and other maternal factors and exposures which may indicate maternal vulnerability or household dysfunction.

Demographic characteristics

The Birth Registration and MNS data provides social and demographic characteristics of mothers and children at time of birth, including sex, socioeconomic status (Socio-economic Indexes for Areas Index of Relative Socio-economic Disadvantage),[27] and geographical remoteness (Accessibility/Remoteness Index of Australia).[28] For remoteness, major cities and inner regional areas were combined given both have greater accessibility of relevant services.

Baseline pregnancy factors

Maternal birth date was determined using all available data sources and maternal age was calculated as the age of mother at time of birth. Parity and duration of birth spacing were derived using sibling birth dates.[29] Maternal history of abortion was identified from maternal hospital records.

Pregnancy complications

The separate and combined effects of key pregnancy complications,[30] identified from maternal hospital records were tested. These complications included hospitalisation during pregnancy for infections, anaemia, diabetes, hypertension, preeclampsia, eclampsia, abruptio placentae, placenta previa, other placental disorders, premature rupture of membranes and renal disorders (see Appendix F, Table F1 for relevant ICD-codes). Admissions for hypertension, preeclampsia or eclampsia were combined in a single category, as were admissions for abruptio placentae, placenta previa or other placental disorders. Non-significant factors, including anaemia and diabetes, were not reported.

Other maternal risk factors and exposures

Other risk factors identified included maternal hospital admissions for any injuries from external causes, and mental health related service presentations (identified from HMDC and MHIS), both excluded substance use and poisoning related service contacts. Maternal substance use (including alcohol) and poisoning related service contacts during pregnancy were identified from HMDC and MHIS.

Sibling contact with child protection services during pregnancy was also identified as an indicator of household dysfunction and maternal risk.

8.3.7 Statistical analysis

All analyses were stratified by infants' Aboriginal status. Statistical analyses were conducted using Stata Version 14.0.

First, prevalence of low birth weight by maternal corrections history, key demographic and pregnancy-related factors (described above) were calculated. Second, univariate analysis was conducted using Poisson regression with robust error variance to estimate the corresponding Relative Risk for individual factors with low birth weight.[31-33] Birth year was the only continuous variable, its relationship with low birth weight was

assessed using independent-samples t-tests for Aboriginal and non-Aboriginal infants separately.

Third, the strength of correlation between pairs of all variables of interest was assessed using Chi-square tests with Cramer's V statistic. For variable pairs with an effect size >0.3,[34] one variable was excluded from the multivariate analysis as determined on the basis of the univariate Relative Risk and statistical significance ($p>0.05$) of each variable with low birth weight. Multivariate Poisson regression, with a robust error variance, was performed for each grouping of variables (demographic factors, baseline pregnancy risk factors, pregnancy complications, and other maternal factors/exposures in pregnancy) with low birth weight. Variables that were not associated with low birth weight (as determined by Relative Risk close to 1) and were not statistically significant ($p>0.05$) were excluded from further analysis. Remaining variables were entered in separate models for Aboriginal and non-Aboriginal infants using Poisson regression, with robust error variance. A manual backwards elimination approach was used to remove individual variables based on their association with low birth weight as determined by Relative Risk (close to null) and statistical significant ($p>0.05$), and Goodness-of-Fit as determined by Akaike Information Criterion (AIC) values.

Finally, the prevalence of key demographic and pregnancy-related risk factors, as ascertained from the univariate analyses and multivariate models, were calculated for maternal corrections history subgroups. The Relative Risk of experiencing each factor were calculated using Poisson regression with robust error variance for each sub-population with maternal corrections history, relative to infants whose mothers had no corrections record.

8.4 Results

There was a 2.1-fold greater risk of low birth weight for Aboriginal infants compared to non-Aboriginal infants (95% CI: 2.0-2.3, $p<.001$). The proportions of low birth weight by key pregnancy risk factors, and associated Relative Risks, are shown in Table 8.2. Despite overlapping confidence intervals among non-Aboriginal children, the point estimates suggest that infants whose mothers were imprisoned before or during pregnancy had a higher prevalence of low birth weight than infants of mothers imprisoned after birth, with community corrections orders, or no corrections records.

There was a statistically significant difference in year of birth for Aboriginal infants with low birth weight (M=1999.33, SD=7.93) and normal/high birth weight (M=1998.55, SD=8.00); t(25542)=-5.17, p<.0001. There was no significant difference in birth years for non-Aboriginal infants with low birth weight (M=1997.82, SD=6.75) and normal/high birth weight (M=1997.75, SD=6.89); t(16364)=-0.32, p=.7476.

Demographic factors associated with low birth weight for Aboriginal and non-Aboriginal infants were female sex, maternal Aboriginal status, and being born in the lowest 50% of areas by socio-economic status. Birth spacing of less than 18-months was a significant risk factor for all infants. All maternal age groups outside of 25-34 years were associated with low birth weight for non-Aboriginal infants, whereas only maternal ages of 35 years and above were significant for Aboriginal infants. All pregnancy complications and other maternal factors were associated with low birth weight, except for renal disorders in pregnancy for non-Aboriginal infants.

Table 8.2 Univariate analysis of potential determinants of low birth weight by Aboriginal status

		Aboriginal Infants, n=25544						Non-Aboriginal Infants, n=16366					
		2500g+	<2500g					2500g+	<2500g				
		n	n	%	RR	(95% CI)	*p*	n	n	%	RR	(95% CI)	*p*
	Infants	22363	3181	12.5				15414	952	5.8			
Maternal Corrections History	Prison (before pregnancy)[1]	2235	574	20.4	2.20	(2.01-2.41)	<.001	549	92	14.4	3.23	(2.63-3.97)	<.001
	Prison (during pregnancy)	622	157	20.2	2.17	(1.87-2.52)	<.001	216	29	11.8	2.66	(1.87-3.79)	<.001
	Prison (after birth)	3024	539	15.1	1.63	(1.48-1.79)	<.001	2287	238	9.4	2.12	(1.83-2.46)	<.001
	Community corrections	4984	732	12.8	1.38	(1.26-1.50)	<.001	596	46	7.2	1.61	(1.21-2.16)	.001
	No corrections record*	11498	1179	9.3				11766	547	4.4			
Demographic Factors													
Sex[2]	Female	10708	1682	13.6	1.19	(1.12-1.27)	<.001	7376	488	6.2	1.14	(1.01-1.29)	.040
	Male*	11578	1488	11.4				7994	461	5.5			
Maternal Aboriginal status	Aboriginal	21259	3090	12.7	1.67	(1.36-2.04)	<.001						
	Non-Aboriginal*	1104	91	7.6				15414	952	5.8			
Socioeconomic status[3]	Very low (0-5%)	5934	971	14.1	1.58	(1.37-1.81)	<.001	899	100	10.0	2.25	(1.81-2.80)	<.001
	Low (6-25%)	9667	1400	12.7	1.42	(1.24-1.62)	<.001	4086	314	7.1	1.61	(1.38-1.88)	<.001
	Medium (26-50%)	4447	582	11.6	1.30	(1.12-1.50)	<.001	4187	248	5.6	1.26	(1.07-1.49)	.006
	High (51-100%)*	2296	225	8.9				6197	288	4.4			
Geographical remoteness[4]	Cities/Inner regional*	8948	1354	13.1				12557	795	6.0			
	Outer regional	3792	518	12.0	0.91	(0.83-1.01)	.064	1689	111	6.2	1.04	(0.85-1.26)	.721
	Remote	4237	487	10.3	0.78	(0.71-0.86)	<.001	797	30	3.6	0.61	(0.43-0.87)	.007
	Very remote	5366	819	13.2	1.01	(0.93-1.09)	.856	314	13	4.0	0.67	(0.39-1.14)	.140
Baseline Pregnancy Risk Factors													
Birth spacing	<18months	2581	444	14.7	1.21	(1.10-1.33)	<.001	992	97	8.9	1.59	(1.30-1.95)	<.001
	Firstborn/18months+*	19782	2737	12.2				14422	855	5.6			
Maternal age	12-19 years	6694	942	12.3	0.98	(0.90-1.07)	.634	1623	124	7.1	1.35	(1.11-1.63)	.002
	20-24 years	8335	1144	12.1	0.96	(0.88-1.04)	.303	3687	250	6.4	1.21	(1.04-1.40)	.013
	25-34 years*	6546	943	12.6				8390	466	5.3			
	35+years	788	152	16.2	1.28	(1.10-1.50)	.002	1714	112	6.1	1.17	(0.95-1.42)	.133
Parity	Nulliparous	7888	1181	13.0	1.10	(1.02-1.19)	.010	7382	477	6.1	1.14	(1.00-1.29)	.054
	Parity 1-2*	9574	1283	11.8				7032	397	5.3			
	Parity 3+	4901	717	12.8	1.08	(0.99-1.18)	.078	1000	78	7.2	1.35	(1.07-1.71)	.011
Previous abortion	Yes	4428	675	13.2	1.08	(1.00-1.17)	.060	3049	234	7.1	1.30	(1.13-1.50)	<.001
	No*	17935	2506	12.3				12365	718	5.5			

		Aboriginal Infants, cont.						Non-Aboriginal Infants, cont.					
		2500g+	<2500g					2500g+	<2500g				
		n	n	%	RR	(95% CI)	*p*	n	n	%	RR	(95% CI)	*p*
Pregnancy Complications													
Hypertension, preeclampsia or eclampsia	Yes	972	299	23.5	1.98	(1.78-2.20)	<.001	732	96	11.6	2.10	(1.72-2.57)	<.001
	No*	21391	2882	11.9				14682	856	5.5			
Any placental disorder	Yes	126	72	36.4	2.96	(2.46-3.57)	<.001	144	40	21.7	3.86	(2.91-5.11)	<.001
	No*	22237	3109	12.3				15270	912	5.6			
Premature rupture of membranes	Yes	805	390	32.6	2.85	(2.61-3.11)	<.001	345	82	19.2	3.52	(2.87-4.32)	<.001
	No*	21558	2791	11.5				15069	870	5.5			
Renal disorders in pregnancy	Yes	28	12	30.0	2.41	(1.50-3.88)	<.001	13	<5	13.3	2.29	(0.63-8.35)	.280
	No*	22335	3169	12.4				15401	950	5.8			
Infection related hospitalisation	Yes	1,759	285	13.9	1.13	(1.01-1.27)	.032	351	31	8.1	1.41	(1.00-1.99)	.051
	No*	20604	2896	12.3				15063	921	5.8			
Other Maternal Factors/Exposures in Pregnancy													
Substance use related service contact[5]	Yes	309	94	23.3	1.90	(1.59-2.27)	<.001	238	52	17.9	3.20	(2.48-4.13)	<.001
	No*	22054	3087	12.3				15176	900	5.6			
Hospitalisation for external causes of injury[6]	Yes	1,143	338	22.8	1.93	(1.75-2.13)	<.001	250	29	10.4	1.81	(1.28-2.57)	.001
	No*	21220	2843	11.8				15164	923	5.7			
Mental health related service contact[7]	Yes	626	141	18.4	1.50	(1.29-1.75)	<.001	371	52	12.3	2.18	(1.68-2.83)	<.001
	No*	21737	3040	12.3				15043	900	5.6			
Sibling in contact with Child Protection	Yes	689	166	19.4	1.59	(1.38-1.83)	<.001	202	34	14.4	2.53	(1.84-3.48)	<.001
	Firstborn/No*	21674	3015	12.2				15212	918	5.7			

*** Reference category**

1. Prison before, not during, pregnancy

2. 88 Aboriginal and 47 non-Aboriginal infants missing sex

3. 22 Aboriginal and 47 non-Aboriginal infants missing socioeconomic status

4. 23 Aboriginal and 60 non-Aboriginal infants missing remoteness

5. Includes substance use and other (MHIS or HMDC).

6. Includes assault, excludes poisoning (HMDC).

7. Excludes substance use related contacts (MHIS or HMDC).

8.4.1 Multivariate regression of low birth weight by Aboriginal status

For Aboriginal infants, geographical remoteness was excluded from the multivariate analysis due to its correlation with socioeconomic status. For non-Aboriginal infants, renal disorders in pregnancy was excluded as it was not statistically significant following univariate analysis with low birth weight (Table 8.2). Birth year was excluded from the full regression model for non-Aboriginal infants as it was not statistically significant after multivariate analysis with other demographic factors (RR 1.00, 95%CI 0.99-1.01, p=.868).

Tables 8.3 and 8.4 present the full and final regression models of low birth weight for Aboriginal (Table 8.3) and non-Aboriginal (Table 8.4) infants. Relative to other factors included in the model maternal corrections history, particularly imprisonment before and during pregnancy, remained a strong determinant of low birth weight after adjusting for other key risk factors for both Aboriginal and non-Aboriginal infants.

Figure 8.2 displays the relationships between maternal corrections history (relative to no corrections record) and low birth weight that were found in the final regression models for Aboriginal and non-Aboriginal infants. Maternal imprisonment before pregnancy had the strongest effect on low birth weight for both Aboriginal and non-Aboriginal infants. The effect of maternal imprisonment before pregnancy also appeared separate from the effect of imprisonment after birth for both Aboriginal and non-Aboriginal infants, despite a small overlap in confidence intervals for non-Aboriginal infants. For Aboriginal infants, the confidence intervals for maternal imprisonment during pregnancy overlapped with those for maternal imprisonment before pregnancy, and to a small but non-significant extent with maternal imprisonment after birth. For non-Aboriginal infants, the effect of maternal imprisonment during pregnancy overlapped with the effects of imprisonment before and after birth.

Table 8.3 Regression model of low birth weight for Aboriginal infants

		Full Model			Final Model		
		RR	(95% CI)	*p*	RR	(95% CI)	*p*
Maternal corrections history	Prison (before pregnancy)	2.01	(1.82-2.21)	<.001	2.02	(1.84-2.22)	<.001
	Prison (during pregnancy)	1.95	(1.67-2.27)	<.001	1.96	(1.68-2.29)	<.001
	Prison (after birth)	1.57	(1.43-1.74)	<.001	1.58	(1.44-1.74)	<.001
	Community corrections	1.31	(1.20-1.43)	<.001	1.32	(1.21-1.43)	<.001
	No corrections record	ref.					
Any placental disorder*	Yes	2.99	(2.47-3.63)	<.001	3.01	(2.48-3.65)	<.001
	No	ref.					
PROM	Yes	2.72	(2.49-2.97)	<.001	2.73	(2.49-2.98)	<.001
	No	ref.					
Renal disorder	Yes	2.40	(1.49-3.86)	<.001	2.40	(1.50-3.87)	<.001
	No	ref.					
Hypertension, preeclampsia	Yes	2.17	(1.95-2.41)	<.001	2.17	(1.95-2.41)	<.001
	No	ref.					
External injury hospitalisation	Yes	1.57	(1.41-1.74)	<.001	1.58	(1.43-1.75)	<.001
	No	ref.					
Socioeconomic status	Very low (0-5%)	1.53	(1.34-1.75)	<.001	1.53	(1.33-1.75)	<.001
	Low (6-25%)	1.40	(1.22-1.59)	<.001	1.39	(1.22-1.59)	<.001
	Medium (26-50%)	1.28	(1.11-1.48)	.001	1.28	(1.11-1.47)	.001
	High (51-100%)	ref.					
Maternal Aboriginal status	Aboriginal	1.40	(1.15-1.71)	.001	1.39	(1.14-1.70)	.001
	Non-Aboriginal	ref.					
Substance use**	Yes	1.33	(1.11-1.61)	.002	1.36	(1.13-1.63)	.001
	No	ref.					
Maternal age at time of birth	35+-years	1.32	(1.13-1.54)	<.001	1.32	(1.13-1.54)	<.001
	<35-years	ref.					
Birth spacing	<18months	1.23	(1.12-1.35)	<.001	1.23	(1.11-1.35)	<.001
	Firstborn/18months+	ref.					
Sex	Female	1.19	(1.11-1.27)	<.001	1.19	(1.11-1.27)	<.001
	Male	ref.					
Parity	Nulliparous	1.18	(1.09-1.28)	<.001	1.17	(1.09-1.26)	<.001
	Parity 1-2	ref.					
	Parity 3+	0.95	(0.87-1.04)	.287	0.96	(0.87-1.05)	.405
Birth year		1.01	(1.00-1.01)	.001	1.01	(1.00-1.01)	.001
Sibling Child Protection	Yes	1.06	(0.91-1.22)	.479			
	Firstborn/No	ref.					
Previous abortion	Yes	1.05	(0.97-1.14)	.229			
	No	ref.					
Mental health related contact	Yes	1.05	(0.90-1.23)	.520			
	No	ref.					
Hospitalisation for infection	Yes	1.01	(0.91-1.14)	.801			
	No	ref.					
	Observations	24,951			24,951		
	AIC	0.7291			0.7289		
	Log pseudolikelihood	-9071.42			-9072.33		

***Includes abruptio placentae, placenta previa, and other placental disorders.**
****Includes hospital admissions and mental health service contacts related to substance use, including alcohol and poisoning.**

Table 8.4 Regression model of low birth weight for non-Aboriginal infants

		Full Model			Final Model		
		RR	(95%	*p*	RR	(95% CI)	*p*
Maternal corrections history	Prison (before pregnancy)	2.36	(1.85-3.00)	<.001	2.48	(1.98-3.12)	<.001
	Prison (during pregnancy)	1.99	(1.38-2.88)	<.001	2.12	(1.48-3.03)	<.001
	Prison (after birth)	1.72	(1.47-2.02)	<.001	1.75	(1.51-2.04)	<.001
	Community corrections	1.41	(1.05-1.88)	.022	1.40	(1.05-1.88)	.022
	No corrections record	ref.					
Any placental disorder*	Yes	4.03	(3.04-5.33)	<.001	4.04	(3.05-5.36)	<.001
	No	ref.					
PROM	Yes	3.11	(2.50-3.85)	<.001	3.16	(2.56-3.91)	<.001
	No	ref.					
Hypertension, preeclampsia	Yes	2.32	(1.89-2.84)	<.001	2.32	(1.90-2.84)	<.001
	No	ref.					
Substance use**	Yes	1.84	(1.37-2.47)	<.001	1.97	(1.49-2.59)	<.001
	No	ref.					
Socioeconomic status	Very low (0-5%)	1.61	(1.29-2.02)	<.001	1.62	(1.30-2.03)	<.001
	Low (6-25%)	1.34	(1.14-1.56)	<.001	1.33	(1.14-1.56)	<.001
	Medium (26-50%)	1.14	(0.96-1.34)	.125	1.13	(0.96-1.34)	.136
	High (51-100%)	ref.					
Birth spacing	<18months	1.57	(1.27-1.96)	<.001	1.55	(1.25-1.93)	<.001
	Firstborn/18months+	ref.					
Parity	Nulliparous	1.24	(1.08-1.43)	.003	1.21	(1.06-1.39)	.005
	Parity 1-2	ref.					
	Parity 3+	1.05	(0.83-1.33)	.682	1.07	(0.84-1.35)	.584
Previous abortion	Yes	1.16	(1.01-1.34)	.042	1.17	(1.02-1.36)	.029
	No	ref.					
Sex	Female	1.13	(1.00-1.28)	.046	1.14	(1.01-1.28)	.041
	Male	ref.					
Mental health related contact	Yes	1.23	(0.92-1.64)	.154			
	No	ref.					
Sibling Child Protection	Yes	1.16	(0.81-1.67)	.411			
	Firstborn/No	ref.					
Hospitalisation for infection	Yes	1.12	(0.79-1.57)	.525			
	No	ref.					
External injury hospitalisation	Yes	1.09	(0.75-1.60)	.641			
	No	ref.					
Maternal age at time of birth	<20-years	0.92	(0.75-1.12)	.410			
	20+-years	ref.					
Geographical remoteness	Outer regional	1.05	(0.87-1.27)	.601			
	Remote	0.68	(0.48-0.97)	.034			
	Very remote	0.87	(0.51-1.48)	.600			
	Major cities/Inner regional	ref.					
	Observations	16,285			16,298		
	AIC	0.4255			0.4250		
	Log pseudolikelihood	-3439.79			-3446.47		

***Includes abruptio placentae, placenta previa, and other placental disorders.**
****Includes hospital admissions and mental health service contacts related to substance use, including alcohol and poisoning.**

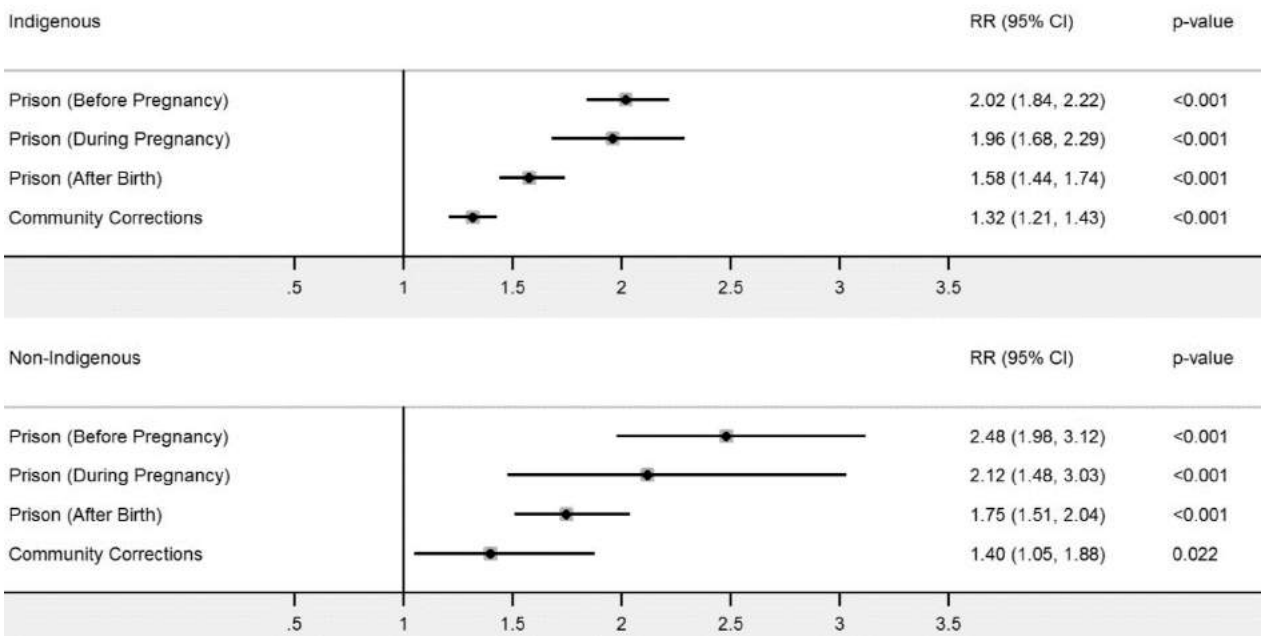


Figure 8.2 The Relative Risk of low birth weight by maternal corrections history relative to no corrections record, in the final regression models for Aboriginal and non-Aboriginal infants

8.4.2 Prevalence of key risk factors by maternal corrections history

The prevalence of key risk factors by maternal corrections history is shown in Table 8.5. The proportion of infants born in areas of very low socioeconomic status was relatively high for all Aboriginal children and did not differ greatly by maternal corrections history. For non-Aboriginal children, infants with any maternal corrections history had higher proportions of very low socioeconomic status than those with no maternal corrections history.

There was a higher prevalence of birth spacing less than 18-months for all infants with any maternal corrections history compared to no maternal corrections history, which was significant for all corrections subgroups except for infants whose mothers were imprisoned during pregnancy. There was a higher prevalence of previous abortion for all infants with any maternal corrections history relative to infants with no maternal corrections history, except for Aboriginal infants whose mothers were first imprisoned after birth.

The prevalence of hospitalisation for hypertension during pregnancy, preeclampsia or eclampsia was lower for all infants with a maternal corrections history relative to no

corrections history, however, this difference was only significant for Aboriginal infants. Hospitalisation for placental disorders did not differ by maternal corrections history for Aboriginal children, and was only higher for non-Aboriginal infants whose mothers were first imprisoned after their birth. Prevalence of hospitalisation for premature rupture of membranes was higher for Aboriginal infants with any maternal corrections history, and likewise for non-Aboriginal infants but the difference was not significant for non-Aboriginal infants whose mothers were imprisoned during pregnancy. Prevalence of renal disorders in pregnancy was low and did not differ by maternal corrections history.

Generally, infants of mothers with any corrections history had higher prevalence of service contact in pregnancy for substance use (including alcohol and poisoning), external causes of injury, and mental health, and sibling contact with the child protection system, compared to infants whose mothers had no corrections history. Prevalence of these service contacts in pregnancy was highest for infants whose mothers were imprisoned before or during pregnancy, compared to infants whose mothers were imprisoned after birth or had community orders alone. For Aboriginal infants, the highest prevalence was experienced by infants whose mothers were imprisoned during pregnancy, while for non-Aboriginal infants it was highest amongst infants whose mothers were imprisoned before pregnancy.

Table 8.5 Prevalence of selected determinants of low birth weight, by maternal corrections history and Aboriginal status

	Aboriginal infants					Non-Aboriginal infants				
	Prison (before preg.) n=2809	Prison (during preg.) n=779	Prison (after birth) n=3563	Comm-unity n=5716	No Correct-ions n=12677	Prison (before preg.) n=641	Prison (during preg.) n=245	Prison (after birth) n=2525	Comm-unity n=642	No Correct-ions n=12313
Very low SES[1]										
%	23.4	22.3	29.2	29.8	26.3	13.7	12.8	13.0	12.3	3.9
RR	0.89	0.85	1.11	1.13	ref.	3.56	3.31	3.37	3.20	ref.
p-value	.001	.015	<.001	<.001		<.001	<.001	<.001	<.001	
Birth spacing <18mth										
%	17.9	10.5	14.0	12.8	9.5	12.2	8.2	9.9	10.4	5.5
RR	1.88	1.10	1.47	1.34	ref.	2.22	1.49	1.81	1.91	ref.
p-value	<.001	.361	<.001	<.001		<.001	.066	<.001	<.001	
Nulliparous										
%	21.5	34.8	38.8	32.5	39.1	33.2	39.2	53.5	43.3	48.1
RR	0.55	0.89	0.99	0.83	ref.	0.69	0.81	1.11	0.90	ref.
p-value	<.001	.021	.773	<.001		<.001	.011	<.001	.023	
Previous abortion										
%	26.9	22.2	17.4	20.7	18.7	36.3	33.5	24.6	28.2	17.6
RR	1.44	1.19	0.93	1.10	ref.	2.07	1.90	1.40	1.60	ref.
p-value	<.001	.014	.067	.002		<.001	<.001	<.001	<.001	
Hypertension, etc.[2]										
%	3.1	4.2	3.8	4.4	6.0	4.4	4.9	4.7	4.8	5.2
RR	0.52	0.71	0.64	0.74	ref.	0.84	0.95	0.91	0.93	ref.
p-value	<.001	.046	<.001	<.001		.366	.843	.331	.694	
Placental disorders										
%	0.8	0.9	0.8	0.8	0.7	0.3	1.6	1.6	0.8	1.1
RR	1.14	1.25	1.17	1.15	ref.	0.29	1.52	1.51	0.73	ref.
p-value	.571	.565	.447	.448		.083	.403	.019	.481	
PROM[3]										
%	6.7	5.4	5.0	5.2	3.9	5.5	3.3	3.5	3.3	2.2
RR	1.73	1.40	1.30	1.35	ref.	2.45	1.47	1.58	1.47	ref.
p-value	<.001	.032	.002	<.001		<.001	.277	<.001	.084	
Substance use[4]										
%	3.3	7.1	2.1	1.6	0.7	12.5	10.2	4.6	3.1	0.4
RR	4.61	9.84	2.89	2.19	ref.	32.02	26.18	11.89	7.99	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	
External injury										
%	10.9	15.0	9.3	6.4	2.9	7.2	6.5	3.5	2.2	0.9
RR	3.83	5.26	3.24	2.24	ref.	7.75	7.05	3.81	2.36	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	.002	
Mental health										
%	6.9	8.7	3.5	3.1	1.6	13.1	11.0	5.1	5.1	1.2
RR	4.36	5.53	2.24	2.00	ref.	10.69	8.98	4.13	4.19	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	
Sibling in contact CP[5]										
%	11.3	14.2	5.1	2.6	0.7	13.1	11.4	4.3	1.6	0.04
RR	15.22	19.22	6.92	3.54	ref.	322.71	281.44	106.31	38.36	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	

1. Very low socioeconomic status defined as 0-5%, 22 Aboriginal and 47 non-Aboriginal infants missing socioeconomic status.

2. Hypertension, preeclampsia, and eclampsia

3. Premature rupture of membranes
4. Substance use, alcohol and poisoning related hospital admissions and mental health service contacts
5. Older sibling in contact with the child protection system during infant's pregnancy

8.5 Discussion

To our knowledge this is the largest study comparing low birth weight outcomes for 1,024 infants born to mothers imprisoned during pregnancy, to infants of mothers with differing maternal corrections histories and infants of mothers with no corrections records. Previous studies have included samples ranging from three to a maximum of 496 infants of mothers imprisoned in pregnancy.[2, 17] Importantly, this is the first study to comprehensively investigate low birth weight outcomes for Aboriginal infants of pregnant prisoners, who are a high-priority population with unique circumstances that warrant their separate consideration from non-Aboriginal infants.

For Aboriginal and non-Aboriginal infants, low birth weight was highest for infants whose mothers were imprisoned before or during pregnancy. There was a lower prevalence of low birth weight for infants whose mothers were first imprisoned after birth compared to those whose mothers were imprisoned before birth. In addition, infants of mothers who had a history of community correctional orders with no imprisonment, had a lower prevalence of low birth weight compared to infants of mothers with any history of imprisonment, and higher prevalence than those infants whose mothers had no corrections history.

The strongest determinants of low birth weight were pregnancy complications (excluding infection related hospitalisations during pregnancy). These complications are also adverse pregnancy outcomes independent of their relationship to low birth weight, and are likely contributed to by other risk factors such as those demographic factors, baseline pregnancy risk factors, and other maternal exposures in pregnancy included in the full regression models. A history of maternal imprisonment, particularly before and during pregnancy, remained a strong determinant of low birth weight after adjusting for these pregnancy complications and other key risk factors.

Our findings are in line with the only other Australian study to date conducted by Walker and colleagues[17] in New South Wales. They too found that women imprisoned during pregnancy experienced similarly poor perinatal outcomes, including low birth weight, as women imprisoned at times other than pregnancy. They did not look

separately at outcomes for women imprisoned 'before' and 'after' pregnancy. We found infants born to mothers imprisoned before or during pregnancy had a higher prevalence of low birth weight than women first imprisoned after birth.

A review of prior studies mainly conducted in the United States found that mothers imprisoned during pregnancy have better birth weight outcomes than similarly disadvantaged women.[2] Together the findings in the present study and Walker et al,[17] suggest a general difference with respect to pregnancy outcomes for Australian women prisoners than those reported in the international literature.

A key question of the literature has been whether maternal imprisonment itself has an effect on birth weight or if it predominantly acts as a proxy for socioeconomic disadvantage and other risk behaviours associated with the prisoner population. We found that prevalence of adverse maternal exposures in pregnancy such as alcohol and other substance use and injury, were highest for those infants whose mothers were also imprisoned during pregnancy (Aboriginal) or before pregnancy (non-Aboriginal). This suggests a possible co-occurrence of these risk factors with timing of imprisonment.

An alternative explanation, that aligns with the findings of the present study, is that the high level of pre-existing disadvantage experienced by women in contact with the prison system places women in a position of vulnerability whereby the experience of imprisonment may have a separate and additive effect that contributes to existing disadvantage. Numerous studies have reported that as adversities accumulate, health and social outcomes deteriorate.[35] This may explain the differences in this study between Indigenous and non-Indigenous populations, as Indigenous women are generally of lower socioeconomic status (stemming from a history of discrimination and disadvantage) which may place them at a "lower baseline" whereby imprisonment has a more significant effect. If maternal imprisonment was acting solely as a proxy for socioeconomic disadvantage and other risk behaviours associated with the prisoner population, we would have expected more overlap between the effects of imprisonment before and after pregnancy, given the models were adjusted for key pregnancy risks including alcohol and substance use and socioeconomic disadvantage.

Walker and colleagues[17] proposed that a key reason for the difference between the findings of Australian and other studies may be the length of prison stay experienced by women prisoners in different jurisdictions. It has been shown that longer prison stays in

pregnancy have been associated with higher birth weight.[36, 37] In our study of young Western Australian children whose mothers were imprisoned after birth and before their second birthday, we found nearly half of prison stays were for less than a fortnight and only one-fifth were for periods of six-months or more.[38] In Western Australia, prisoners sentenced for periods less than six-months, in general, are not provided with a management plan or access to treatment programs.[39]

It is likely that maternal imprisonment during pregnancy has varied effects on infant birth weight depending on the characteristics of the mother, infant, and characteristics of imprisonment in pregnancy, particularly duration, frequency and timing in relation to gestational age. Prison may have a beneficial effect for some infants in certain circumstances, and a detrimental effect for others. To identify which infants are at greater risk, further analyses examining individual predicted probabilities should be conducted.

Regardless, the results of the present study in Western Australia clearly demonstrate the impact of imprisonment of women before and during pregnancy resulting in a greater risk of low birth weight for their infants. These results highlight the importance of criminal justice policies that address both the underlying vulnerabilities of women prisoners generally and the needs of pregnant prisoners specifically. Western Australia has made significant steps towards providing women-centred prison services. This includes, notably, the establishment of the Boronia Pre-release Centre for Women in 2004, which has been described as a model for good practice in the management of women prisoners.[40] This study highlights the importance of the continuation and expansion of women-centred approaches throughout the criminal justice system, and the need for these approaches to extend to addressing the potential impacts on women's infants and children as a priority issue.

8.5.1 Limitations

For infants whose mother had a prison record at any time, the sampling method included comparatively fewer non-Aboriginal infants whose mothers had a prison record before or during pregnancy. Smaller numbers of observations of non-Aboriginal infants with low birth weight were reported within the group imprisoned before or during pregnancy. This will have affected power to detect relationships, but should not have introduced any bias.

As gestational age was not obtained and birth date was provided to month of birth only, pregnancy was taken to begin nine-months prior to month of birth for all infants. Accordingly, some records of exposure (including imprisonment) that were attributed to having occurred during pregnancy may have occurred prior to pregnancy if gestation was shorter than nine-months. There is evidence, however, that the adverse events within the preconception period (6-0 months before pregnancy) can increase infant mortality risk.[41, 42]

In using administrative data and only having primary diagnosis codes for key service contacts (not co-diagnoses), the study has not fully captured heavy drinking or substance use in pregnancy, mental illness, or injuries indicative of domestic violence in pregnancy within the study population. O'Leary and colleagues[43] examined alcohol-use disorders in pregnant women and the extent of under-reporting using Western Australian linked data. They used hospital, mental health service, drugs and alcohol service, and the register for developmental anomalies, and found 70% of mothers of children diagnosed with foetal alcohol syndrome did not have an alcohol diagnosis recorded in pregnancy. This suggests the relative risks associated with drinking or substance use in pregnancy, or mental illness, or injuries may be understated, due to misclassification of some affected by these risks as not.

Maternal smoking in pregnancy is an important risk factor for low birth weight that was not fully captured in the study. It is likely that smoking in pregnancy will have been partly captured by maternal corrections history and socioeconomic status. For example, for infants born from 1998 onwards, maternal smoking in pregnancy was high for all Indigenous and non-Indigenous infants whose mothers had any corrections history (range 58-78%), compared to infants whose mothers had no corrections record (41% Indigenous, 19% non-Indigenous).

Hospital data was not available for second-generation children. While explanatory variables based on hospital data were primarily taken from maternal hospital records (available for all mothers), there may have been some missed some cases of chromosomal abnormalities, and alcohol and other substance use related service contacts in pregnancy, for the second-generation children.

8.6 Conclusions

This study adds to the literature that suggests Australian infants born to mothers imprisoned during pregnancy do not generally experience the improved birth weight outcomes reported in the international literature. This study demonstrates that infants of women imprisoned in Western Australia, particularly before and during pregnancy, experience an increased risk of low birth weight. Infants with mothers imprisoned before or during pregnancy experience a higher prevalence of maternal risk exposures in pregnancy related to alcohol and other substance use, injury and mental distress. However, the strength of relationship between a history of maternal imprisonment before or during pregnancy is maintained after adjusting for these additional maternal risk exposures, suggesting that maternal imprisonment may have a separate impact on risk of low birth weight. Identifying whether particular groups of infants of women prisoners experience the worse outcomes is an important next step.

8.7 References

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9 Study V
Predictors of Low Birth Weight and Infant Mortality in Aboriginal Infants of Mothers Imprisoned During Pregnancy

The following chapter addresses Research Aim 5 by identifying predictors of low birth weight and infant mortality for infants of pregnant prisoners, with a focus on maternal incarceration factors.

9.1 Abstract

Rationale

Aboriginal infants born to mothers imprisoned during pregnancy are at increased risk of low birth weight and infant mortality.

Objective

To develop predictive models to identify infants at the highest risk of poor outcomes when their mother is imprisoned during pregnancy.

Methods

Predictors of poor infant outcomes, including characteristics of maternal corrections records, were examined through univariate analysis using logistic regression with a robust error variance. A multivariate predictive model was derived using logistic regression with robust error variance. The most parsimonious model was achieved using a backwards elimination approach to remove variables based on Goodness-of-Fit. The predictive ability of the model was assessed using classification statistics.

Results

A multivariate model of infant mortality was not able to be developed due to the small number of observations of infant mortality (n=27). Significant predictors of infant mortality at the univariate level included: male sex; any placental disorder; maternal imprisonment as a sentenced offender for less than 14-days during pregnancy; last release type in pregnancy being related to a fine; a maternal prison record before birth for fraud offences; and maternal imprisonment before birth for breach of justice procedures.

The multivariate predictive model for low birth weight retained eight factors, including seven risk factors: premature rupture of membranes; maternal imprisonment in pregnancy for a period of less than two-months; maternal imprisonment during pregnancy for public order offences; timing of first maternal prison reception in pregnancy occurring preconception; a maternal prison record before birth for breach of justice procedures; hospitalisation for external injury in pregnancy; and maternal imprisonment during pregnancy for theft offences. Having a sibling in contact with the child protection system during pregnancy was the only factor in the multivariate model

associated with a lower odds of low birth weight. Overall the model had high specificity, however, sensitivity was low and model discrimination was poor.

Conclusions

The predictive model developed for low birth weight had poor discrimination, however, several characteristics of maternal corrections records associated with low birth weight and infant mortality were able to be identified. Infants whose mothers are imprisoned for short periods during pregnancy, particularly prison stays less than two-weeks, have increased risk of poor outcomes.

9.2 Introduction

The previous chapters investigated whether maternal imprisonment during pregnancy was a determinant of infant mortality (Chapter 7) and low birth weight (Chapter 8). Aboriginal infants whose mothers were imprisoned in pregnancy experienced the highest rates of infant mortality, and also experienced increased prevalence of low birth weight compared to either Aboriginal or non-Aboriginal infants whose mothers were first imprisoned after birth, had community-based corrections orders, or no record of imprisonment.

The analyses in this chapter focus exclusively on Aboriginal infants whose mothers were imprisoned at least once during their pregnancy, to examine whether characteristics of maternal contact with the corrections system predict pregnancy outcomes for infants.

Non-Aboriginal infants were not combined with the Aboriginal infants due to the important differences between these populations with respect to their risk of infant mortality and low birth weight, as reported in the previous chapters. In addition, the small number of non-Aboriginal infants whose mothers were imprisoned in pregnancy (discussed in Chapter 4), and the limited number of observations of infant mortality (n=<5) and low birth weight (n=29) within this group complicates the analysis and interpretation of the non-Aboriginal subsample.

This chapter aims to explore factors related to maternal corrections history, before and during pregnancy, that may be related to risk of low birth weight and infant mortality. Predictive models are used to identify the risk factors available from routinely-collected administrative data that are best able to predict the probability of low birth weight and separately of infant mortality for Aboriginal infants whose mothers are imprisoned during pregnancy. The rationale for the study was to develop a predictive model that could be used as a tool to identify infants at the highest risk of poor outcomes when their mother is imprisoned during pregnancy.

9.3 Methods

The methodology for the broader data linkage project is described in Chapter 4, including the sources of data, linkage process and sampling of the total study population.

The analyses in this chapter build on the previous infant mortality and low birth weight studies and therefore use the same definitions for infant mortality and low birthweight outcomes, pregnancy and birth dates, and demographic and pregnancy-related risk factors as detailed in Chapters 7 and 8.

The methods specific to this chapter, including the sampling, ascertainment of maternal corrections predictor variables, and analytical approach, are described below.

9.3.1 Study sample

The sample for this study was drawn from the total study population including second-generation children (Chapter 4). The study sample included liveborn Aboriginal infants (aged 0-1 year) whose mothers had at least one record of imprisonment in a Western Australian prison within the nine-month period prior to their birth month, or during their birth month. Pregnancy was defined in this way as infant birthdate was provided to month only and gestational age was not available in the data extracted for the project (Chapters 7 and 8).

The sample for the low birth weight analyses included infants born from October 1985 to December 2013 to ensure exposure data were available for all pregnancy risk factors. The infant mortality sample was limited to children born October 1985 to June 2013, to ensure 12-months of follow up for death outcome data.

Multiple gestation pregnancies were excluded from the low birth weight analysis. Infants with a chromosomal abnormality were also excluded from both the low birth weight and infant mortality samples.

9.3.2 Definition of predictor variables

The selection of model parameters was guided by the conceptual framework outlined in Chapter 3. Key demographic factors, baseline pregnancy risk factors, pregnancy complications, and other maternal factors and exposures during pregnancy, were as described in the studies of determinants of infant mortality and low birth weight in Chapters 7 and 8. Potential predictors of infant mortality and low birth weight related to maternal contact with corrective services were defined for the analyses contained in this chapter.

Demographic characteristics

The demographic characteristics of infants were ascertained primarily from the Birth Registration and Midwives Notification System data. Characteristics included infant's sex, and the socioeconomic status and geographical remoteness of mother's place of residence at time of infant's birth. Remoteness categories of 'Remote' and 'Very remote' were combined based on the similarity of the Odds Ratio (OR) and 95% Confidence Interval (CI) of the individual categories so as increase cell counts for model stability. Aboriginal status of infants and mothers was ascertained using the Derived Indigenous Status Flag Variable provided through the WADLS, and records were checked in accordance with the process described in Chapter 4.

Baseline pregnancy risk factors

Maternal birth date was determined using all available data, as described in Chapter 4. Maternal age at time of infant's birth was reclassified as a composite measure of whether the mother was imprisoned in pregnancy in a juvenile or adult prison, and maternal age for adult prisoners aged 35-years or above at time of birth as this age range was identified as having the highest risk for poor outcomes for the Aboriginal population in our studies described in Chapters 7 and 8. Parity and birth spacing were determined using sibling birth date data. Maternal history of abortion was determined using maternal hospitalisation data.

Pregnancy complications

Key pregnancy complications,[1] were identified from maternal hospital data. Complications included hospitalisation during pregnancy for infections, and hospitalisations for premature rupture of membranes. Hospitalisations for hypertension, preeclampsia or eclampsia were combined, as were hospitalisations for abruptio placentae, placenta previa and other placental disorders. Renal disorders in pregnancy were omitted as there were no observations within the study sample.

Other maternal risk factors and exposures during pregnancy

Maternal hospitalisations for injuries from external causes, mental health service presentations, and service contacts related to alcohol and other substance use during pregnancy, were identified from hospital and mental health data. Sibling contact with the child protection system during pregnancy was also identified.

Maternal corrections predictors

Potential predictors of low birth weight and infant mortality related to maternal corrections records were identified from the Department of Justice data. Variable definitions were guided by the existing literature, the conceptual framework, and findings in previous studies as reported in Chapters 5 and 6. A full list of potential predictors that were considered is provided in Appendix G (Table G1).

As mothers in our sample could be imprisoned multiple times and for any length of time during pregnancy, and gestational age was not available for infants, three variables were defined relating to timing of imprisonment during pregnancy; timing of first prison reception in pregnancy, timing of last prison discharge in pregnancy, and a dichotomous variable for whether the infant was or was not born during mother's imprisonment term.

Length of imprisonment in pregnancy was defined by mother's total days of imprisonment in pregnancy, and mother's longest record of imprisonment in pregnancy. Three-categories of length of imprisonment in pregnancy (0-13 days, 14-59 days, and 60+ days) were determined based on an investigation of the distribution of birth weight data by days of maternal imprisonment during pregnancy for low birth weight cases in the sample (Appendix G, Figure G1).

The number of community corrections records and prison records in pregnancy were considered as measures of frequency of maternal offending and supervision by corrective services. The sentence type of mother's first and longest prison record in pregnancy was determined. Given the interrelationship between timing, length, frequency and sentence type of imprisonments in pregnancy, combined measures of these factors were created and tested (see Appendix G, Table G1).

Release type of mother's last imprisonment in pregnancy was defined in two-ways. First, by the likelihood of continued supervision by corrective services post-release, if the prisoner was likely to be supervised (e.g. parole, community-order, etc.) or unsupervised (e.g. released to freedom, fined, etc). Second, a dichotomous measure of whether or not the release involved a fine was used, given the high level of socioeconomic disadvantage experienced within the study population (Studies I-IV).

Prison facility location of mother's first imprisonment in pregnancy was defined broadly as being either in metropolitan Perth or regional Western Australia.

As complete corrections records were obtained for mothers, including records prior to their infant's birth, variables were able to be defined as occurring before and during the index pregnancy. These included the number of prison records, community orders, or total corrections records within one or two years before the start of pregnancy. Whether an infant's mother was a juvenile or adult at the time of her first imprisonment or first corrections record was also determined as was a variable indicating whether the imprisonment during pregnancy was the mother's first imprisonment.

Offence type variables were created separately for prison records and for corrections records (including both prison records and community orders), and for entries within pregnancy and also any time before birth. Offence types were categorised by the seven groupings described in Chapters 4 and 6, and as detailed in Appendix G (Table G2).

9.3.3 Statistical analyses

The analytical approach broadly involved three key components; i) examining risk factors, in particular maternal corrections and offence history, through univariate analysis with the outcome and testing for collinearity and correlations between variables to select the set of predictor variables; ii) deriving the predictive model; and iii) determining the predictive ability of the model. Analyses were performed separately for low birth weight and infant mortality outcomes, however, there were too few observations of infant mortality (n=27) to develop a predictive model and so only the results of the univariate analysis are reported for infant mortality here.

Selecting the set of predictor variables

Univariate analysis was performed for low birth weight and infant mortality outcomes using logistic regression with a robust error variance to estimate ORs for individual predictors with each outcome. Infant birth year was the only continuous variable and was assessed using independent-samples t-tests for low birth weight and infant mortality separately.

For low birth weight, the predictor with the strongest univariate association with low birth weight or infant mortality, within each sub-category of maternal corrections history and offence type history (Appendix G, Tables G1 and G2) was selected for further analysis. These were combined with other demographic and pregnancy-related factors and tested for multicollinearity using tolerance and variance inflation factor

(VIF) values.[2] Birth spacing and parity were the only variables with VIF values above 2.5.[2] After exclusion of either variable the condition index remained extremely high at 1660.94-1670.45, indicating multicollinearity was a significant problem.[2] As such, the strength of pairwise correlations were assessed using Chi-square tests with Cramer's V statistic. For variable pairs with an effect size greater than 0.3,[3] one variable was excluded from further multivariate analysis based on the strength of relationship with low birth weight in univariate analysis. A summary of all pairwise correlations with an effect size greater than 0.3 is provided in Appendix G (Table G3). Length and sentence type of longest imprisonment in pregnancy, were combined into a single variable with five categories: i) Sentenced/1-13days; ii) Unsentenced/1-13days; iii) Sentenced/14-59days; iv) Unsentenced/14-59days; v) 60+days. This variable was retained based on the strength of univariate association with low birth weight. Infant birth year, socioeconomic status, maternal age, if infant was born in prison, number of community orders in pregnancy, and release type of last imprisonment in pregnancy were excluded based on the strength of their correlation with the combined variable for length and sentence type of longest imprisonment in pregnancy. Birth spacing and parity were excluded on the basis of their correlation with the variable for sibling contact with the child protection system, which had a stronger association with low birth weight. Maternal Aboriginal status, hypertension and related conditions, substance use related service contacts in pregnancy, and offence type variables for drug and fraud offences, were excluded from further multivariate analysis due to small individual cell counts. The condition index for the remaining variables was less than 30, indicating that multicollinearity was not a serious concern.[2]

Deriving the predictive model

There were 16 remaining variables, which was within the maximum number of predictor variables for a reliable model using logistic regression. The maximum number of predictor variables was estimated at 18 to 37, calculated as M/20 to M/10, where $M=3n_1n_2/N$ (n_1= cases of low birthweight, n_2= normal/high birth weight, N= total sample size).[4] The remaining variables were entered with low birth weight into a full logistic regression model (Model 1), with a robust error variance. A backwards elimination approach was used to determine the most parsimonious model (Model 2), by removing individual variables based on Goodness-of-Fit as determined by Akaike Information Criterion (AIC) values and classification statistics.

Assessing predictive ability

The predictive ability of Models 1 and 2 was estimated and compared using classification statistics and Receiver Operating Characteristic (ROC) curves. Classification statistics include the sensitivity and specificity of the models, which measure the model's ability to correctly identify individuals with low birth weight or dying in infancy (sensitivity), and to correctly identify individuals who do not develop the outcomes of interest (specificity). The ROC curve plots the true-positive rate (sensitivity) against the false-positive rate at different thresholds to measure the accuracy of the model. Greater area under the ROC curve corresponds with a greater ability to identify true-positives over false-positives. In general, an area under the ROC curve of 0.5 means the model has no ability to discriminate between individuals with and without the outcome, 0.7-0.8 is acceptable, and above 0.8 is considered ideal.[5] For the most parsimonious model (Model 2), probabilities of low birth weight for each predictor variable (adjusted for all other variables) were estimated. The reliability of predicted values using Model 2 was also assessed.

9.4 Results

9.4.1 Univariate analysis of potential predictors of low birth weight and infant mortality

Infant mortality

Table 9.1 reports the results of the univariate analysis of the categorical risk factors for infant mortality and low birth weight.

For infant mortality, male sex was the only demographic factor with a statistically significant association with the outcome (OR=2.55, 95%CI 1.10-5.89, *p*=0.029). There were no baseline pregnancy risk factors associated with infant mortality. Placental disorders were the only pregnancy complication with a significant association with infant mortality (OR=8.78, 95% CI 1.73-44.45, *p*=0.009), however, there were very small numbers of observations (n=<5) in the infant mortality sample. There were no risk factors within the 'other maternal factors and exposures during pregnancy' grouping, with a significant association with infant mortality.

Several factors related to maternal corrections history were associated with infant mortality, as shown in Table 9.1. Three-quarters of all infants who died in the sample,

had mothers imprisoned for less than two-weeks in total during pregnancy. Odds of mortality was highest for infants whose mothers were sentenced prisoners and imprisoned for less than two-weeks, for their longest imprisonment in pregnancy (OR=6.28, 95%CI 1.41-28.07, p=0.016). Thirteen-percent of infants died who had mothers whose last prison release type in pregnancy stated “fine paid” or “fined ex-court” (OR=6.49, 95%CI 2.90-14.52, p<0.001). Similarly, nearly 11% of infants died whose mothers had a record of imprisonment for a fraud related offence before their birth (OR=3.69, 95%CI 1.42-9.57, p=0.007). Having a maternal prison record for breach of justice procedures before birth, was another significant risk for infant mortality (OR=2.28, 95%CI 1.04-4.99, p=0.039) whereas having a mother imprisoned for theft related offences during pregnancy was associated with reduced odds of infant death (OR=0.21, 95%CI 0.06-0.70, p=0.011).

Low birth weight

As shown in Table 9.1, there were no demographic or baseline pregnancy risk factors associated with low birth weight based on the univariate analysis. Premature rupture of membranes was the only pregnancy complication with a significant association with low birth weight (OR=3.59, 95%CI 1.90-6.77, p<0.001). There were no risk factors within the ‘other maternal factors and exposures during pregnancy’ grouping, which had a statistically significant association with low birth weight.

Being born while the mother was imprisoned during pregnancy, was associated with reduced odds of low birth weight (‘Not born in prison’ OR=2.05, 95%CI 1.11-3.76, p=0.021). This variable was highly correlated with the length of imprisonment in pregnancy (see Appendix G, Table G4). Infants who were born in prison had mothers who were imprisoned for significantly more days in pregnancy (M=128.70, SD=72.58) compared with those who weren’t born in prison (M=25.31, SD=39.89) p<.0001. Infants whose mothers were imprisoned for less than two-months during their longest imprisonment in pregnancy had increased odds of low birth weight, and the odds of this outcome was higher for unsentenced mothers. Having a mother who was imprisoned during pregnancy for public order offences, was a significant risk factor for low birth weight (OR=2.58, 95%CI 1.44-4.63, p=0.001), whereas having a mother with a record of imprisonment for offences against the person before birth was associated with reduced odds of low birth weight (OR=0.67, 95%CI 0.46-0.99, p=0.042).

Table 9.1 Potential predictors of low birth weight and infant mortality for infants of mothers imprisoned in pregnancy (univariate analysis)

	Birth weight (n=779)						Infant mortality (n=802)					
	2500g+	<2500g					Sur.[#]	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Infants	622	157	20.2				775	27	3.3			
Demographic Factors												
Sex[1]												
Male	297	82	21.6	1.19	(0.84-1.69)	.333	373	19	4.9	2.55	(1.10-5.89)	.029
Female*	323	75	18.8				400	8	2.0			
Maternal Aboriginal status												
Aboriginal	608	150	19.8	0.49	(0.20-1.24)	.135	756	25	3.2	0.31	(0.07-1.42)	.133
Non-Aboriginal*	14	7	33.3				19	<5				
Socioeconomic status[2]												
Very low (0-5%)	137	36	20.8	1.46	(0.78-2.72)	.233	174	7	3.9	1.54	(0.39-6.09)	.537
Low (6-25%)	252	62	19.8	1.37	(0.77-2.43)	.286	316	11	3.4	1.33	(0.37-4.87)	.662
Medium (26-50%)	132	40	23.3	1.68	(0.91-3.11)	.097	167	6	3.5	1.38	(0.34-5.62)	.656
High (51-100%)*	100	18	15.3				115	<5				
Geographical remoteness[3]												
Major cities/Inner regional*	422	100	19.2				519	16	3.0			
Outer regional	103	24	18.9	0.98	(0.60-1.61)	.947	123	6	4.7	1.58	(0.61-4.13)	.348
Remote	46	15	24.6	1.38	(0.74-2.56)	.315	130	5	3.7	1.25	(0.45-3.47)	.672
Very remote	50	17	25.4	1.43	(0.79-2.59)	.232						
Baseline Pregnancy Risk Factors												
Multiple gestation												
Yes							22	<5		2.74	(0.61-12.30)	.189
No*							753	25	3.2			
Previous abortion												
Yes	132	41	23.7	1.31	(0.88-1.97)	.189	169	<5		1.02	(0.41-2.58)	.959
No*	490	116	19.1				606	21	3.4			
Birth spacing												
Firstborn	210	61	22.5	1.18	(0.82-1.72)	.377	267	7	2.6	0.69	(0.28-1.70)	.423
<18months	70	12	14.6	0.70	(0.36-1.35)	.284	86	<5		1.39	(0.40-3.76)	.721
18months+*	342	84	19.7				422	16	3.7			

	Birth weight cont.						Infant mortality cont.					
	2500g+	<2500g					Sur.	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Baseline Pregnancy Risk Factors cont.												
Maternal age												
Juvenile	105	34	24.5	1.41	(0.91-2.19)	.120	140	<5		0.19	(0.03-1.41)	.104
Adult <35 years*	498	114	18.6				608	23	3.7			
Adult 35+ years	19	9	32.1	2.07	(0.91-4.70)	.082	27	<5		3.46	(0.98-12.22)	.095
Parity												
Nulliparous	210	61	22.5	1.19	(0.80-1.77)	.392	267	7	2.6	0.68	(0.26-1.76)	.428
Parity 1-2*	254	62	19.6				312	12	3.7			
Parity 3+	158	34	17.7	0.88	(0.55-1.40)	.594	196	8	3.9	1.06	(0.43-2.64)	.898
Pregnancy Complications												
Any placental disorder[4]												
Yes	5	<5		1.59	(0.31-8.29)	.581	7	<5		8.78	(1.73-44.45)	.009
No*	617	155	20.1				768	25	3.2			
Premature rupture of membranes												
Yes	23	19	45.2	3.59	(1.90-6.77)	<.001	43	<5		0.65	(0.09-4.95)	.681
No*	599	138	18.7				732	26	3.4			
Infection related hospitalisation in pregnancy												
Yes	69	22	24.2	1.31	(0.78-2.19)	.310	88	<5		0.98	(0.29-3.31)	.996
No*	553	135	19.6				687	24	3.4			
Hypertension, preeclampsia or eclampsia[5]												
Yes	24	9	27.3	1.52	(0.69-3.33)	.301	35	0				
No*	598	148	19.8				740	27	3.5			
Other Maternal Factors/Exposures during Pregnancy												
Substance use related service contact[6]												
Yes	43	12	21.8	1.11	(0.57-2.17)	.750	57	<5		1.01	(0.23-4.37)	.992
No*	579	145	20.0				718	25	3.4			
Hospitalisation for external causes of injury[7]												
Yes	86	31	26.5	1.53	(0.97-2.42)	.065	113	<5		0.73	(0.22-2.47)	.616
No*	536	126	19.0				662	24	3.5			
Mental health related service contact[8]												
Yes	53	15	22.1	1.13	(0.62-2.07)	.682	65	<5		0.87	(0.20-3.78)	.857
No*	569	142	20.0				710	25	3.4			

	Birth weight cont.						Infant mortality cont.					
	2500g+	<2500g					Sur.	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Other Maternal Factors/Exposures during Pregnancy cont.												
Sibling in contact with child protection[9]												
Firstborn	210	61	22.5	1.15	(0.79-1.68)	.464	397	16	3.9	0.65	(0.26-1.60)	.350
Yes	95	16	14.4	0.67	(0.37-1.20)	.175	267	7	2.6	0.89	(0.29-2.73)	.844
No*	317	80	20.2				111	4	3.5			
Maternal Corrections History												
Timing of first prison reception												
First reception prior to pregnancy start date	38	15	28.3	1.85	(0.96-3.58)	.066	54	<5		0.43	(0.06-3.30)	.415
First trimester (0-3 months)*	291	62	17.6				346	15	4.2			
Second or third trimester (4-9 months)	293	80	21.5	1.28	(0.89-1.85)	.188	375	11	2.9	0.68	(0.31-1.49)	.334
Infant born in prison												
Yes*	97	13	11.8				109	<5				
No	525	144	21.5	2.05	(1.11-3.76)	.021	666	24	3.5	1.31	(0.39-4.43)	.665
Total days imprisoned in pregnancy												
1-13 days	316	97	23.5	2.54	(1.50-4.30)	.001	410	20	4.7	2.89	(0.85-9.87)	.090
14-59 days	149	41	21.6	2.27	(1.26-4.10)	.006	187	<5		1.27	(0.28-5.76)	.757
60+ days*	157	19	10.8				178	<5				
Sentence type of longest prison record in pregnancy												
Sentenced*	180	38	17.4				222	6	2.6			
Unsentenced	258	79	23.4	1.45	(0.94-2.23)	.091	228	8	2.3	0.88	(0.30-2.56)	.808
Default of fine	184	40	17.9	1.03	(0.63-1.68)	.907	215	13	5.7	2.24	(0.83-6.00)	.109
Sentence type and length longest prison record in pregnancy												
Sentenced (incl. default of fine), 1-13 days	152	41	21.2	2.20	(1.21-4.01)	.010	185	14	7.0	6.28	(1.41-28.07)	.016
Unsentenced, 1-13 days	171	58	25.3	2.77	(1.56-4.91)	<.001	233	7	2.9	2.49	(0.51-12.17)	.259
Sentenced (incl. default of fine), 14-59 days	82	20	19.6	1.99	(1.00-3.98)	.051	103	<5		2.42	(0.40-14.73)	.338
Unsentenced, 14-59 days	70	20	22.2	2.33	(1.16-4.69)	.017	88	<5		0.94	(0.08-10.56)	.962
60+ days	147	18	10.9				166	<5				
Community corrections records in pregnancy												
0*	255	59	18.8				317	14	4.2			
1	190	47	19.8	1.07	(0.70-1.64)	.759	233	9	3.7	0.87	(0.37-2.06)	.759
2+	177	51	22.4	1.25	(0.82-1.90)	.307	225	<5		0.40	(0.13-1.24)	.113

	Birth weight cont.						Infant mortality cont.					
	2500g+	<2500g					Sur.	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Maternal Corrections History cont.												
Prison records in pregnancy												
1	482	128	21.0	1.28	(0.82-2.00)	.274	606	24	3.8	2.23	(0.66-7.50)	.195
2+*	140	29	17.2				169	<5				
Prison location of first imprisonment in pregnancy												
Metropolitan*	445	113	20.3				557	18	3.1			
Regional	177	44	19.9	0.98	(0.66-1.45)	.915	218	9	4.0	1.28	(0.57-2.89)	.556
Last release type in pregnancy 'Fine paid/Fined ex-court'[10]												
Yes	59	20	25.3	1.41	(0.82-2.43)	.212	73	11	13.1	6.49	(2.90-14.52)	<.001
No*	554	133	19.4				689	16	2.3			
Offence type[11]												
Prison record for offences against the person, before birth												
Yes	277	53	16.1	0.67	(0.46-0.99)	.042	326	13	3.8	1.05	(0.49-2.28)	.894
No*	288	82	22.2				370	14	3.7			
Prison record for theft offences, in pregnancy												
Yes	200	51	20.3	1.12	(0.76-1.66)	.565	255	<5		0.21	(0.06-0.70)	.011
No*	352	80	18.5				424	24	5.4			
Prison record for fraud offences, before birth												
Yes	39	11	22.0	1.20	(0.60-2.40)	.614	50	6	10.7	3.69	(1.42-9.57)	.007
No*	526	124	19.1				646	21	3.2			
Community or prison record for drug offences, before birth												
Yes	63	8	11.3	0.47	(0.22-1.00)	.050	74	<5		0.36	(0.05-2.67)	.316
No*	546	148	21.3				687	26	3.7			
Prison record for public order offences, in pregnancy												
Yes	36	20	35.7	2.58	(1.44-4.63)	.001	52	<5		2.10	(0.70-6.30)	.187
No*	516	111	17.7				627	23	3.5			
Prison record for traffic offences, before birth												
Yes	148	30	16.9	0.81	(0.51-1.26)	.342	174	7	3.9	1.05	(0.44-2.53)	.913
No*	417	105	20.1				522	20	3.7			
Prison record for breach of justice procedures, before birth												
Yes	212	61	22.3	1.37	(0.94-2.01)	.102	271	16	5.6	2.28	(1.04-4.99)	.039
No*	353	74	17.3				452	11	2.5			

*** Reference category**
 # Survived to 12-months
Notes:

1	**2 infants missing sex**
2	**2 infants missing socioeconomic status (3 infant mortality)**
3	**2 infants missing remoteness (3 infant mortality). "Remote" and "Very remote" combined for infant mortality due to low cell counts.**
4	**Incudes abruptio placentae, placenta previa, and other placental disorders**
5	**Hospitalisation for hypertension, preeclampsia or eclampsia during pregnancy**
6	**Substance use or poisoning related service contact (hospital or mental health service)**
7	**Hospitalisation for external causes of injury in pregnancy (excludes poisoning)**
8	**Mental health service contact in pregnancy (excludes substance use) (hospital or mental health service)**
9	**Older sibling(s) in contact with child protection system in infant's pregnancy**
10	**13 infants missing release type**
11	**Missing offence type: 96 prison record in pregnancy; 79 prison record before birth; 14 community order or prison record before birth**

9.4.2 Predictive (multivariate) model of low birth weight

Due to the small number of observations of infant mortality (n=27) and small individual cell counts with the potential for model instability (n<5), mortality was examined solely through univariate analysis (above).

A multivariate predictive model was developed for low birth weight. The starting model (Model 1) and final predictive model (Model 2) of low birth weight, are shown in Table 9.2. The final predictive model retained eight variables including five factors related to maternal corrections history, one pregnancy complication, and two other exposures in pregnancy.

Premature rupture of membranes had the strongest association with low birth weight in the final predictive model (OR=3.21, 95%CI 1.52-6.80, *p*=0.002). Maternal imprisonment for public order offences in pregnancy was also a strong predictor of low birth weight (OR=3.00, 95%CI 1.57-5.73, *p*=0.001), as was mother's longest imprisonment in pregnancy being as an unsentenced prisoner for 1-13 days (OR=2.94, 95%CI 1.54-5.64, *p*=0.001) or 14-59 days (OR=2.69, 95%CI 1.29-5.61, *p*=0.008). Within the predictive model, timing of mother's first prison reception in pregnancy was significant, but only for infants whose mother's first reception was prior to nine months before birth (i.e. preconception) (OR=2.56, 95%CI 1.22-5.36, *p*=0.013). Likewise, maternal imprisonment for breach of justice procedures before birth (OR=1.65, 95%CI 1.08-2.51, *p*=0.020), and maternal imprisonment for theft related offences during pregnancy (OR=1.56, 95%CI 1.00-2.43, *p*=0.050), only became significant predictors of low birth weight in combination with the other variables within the predictive model. This was also the case for injury-related hospitalisations and having an older sibling in contact with the child protection system during pregnancy.

Regarding the predictive ability of the models, specificity or the ability of the model to correctly identify infants without low birth weight was high at 98.7%, the sensitivity of the model for identifying infants with low birth weight was low at 6.9%. The sensitivity and specificity of the final predictive model at different probability cut-offs are shown in Figure 9.1.

Table 9.2 Predictive (multivariate) models of low birth weight for Aboriginal infants whose mothers were imprisoned in pregnancy

	Model 1: Starting model			Model 2: Final model		
	OR	(95% CI)	*p*	OR	(95% CI)	*p*
Premature rupture of membranes						
Yes	3.27	(1.51-7.07)	.003	3.21	(1.52-6.80)	.002
No	ref.					
Nature of longest record in pregnancy						
Sentenced (incl. default of fine), 1-13 days	1.55	(0.80-3.01)	.196	1.86	(0.97-3.56)	.062
Unsentenced, 1-13 days	2.72	(1.39-5.31)	.003	2.94	(1.54-5.64)	.001
Sentenced (incl. default of fine), 14-59 days	1.45	(0.68-3.09)	.333	1.64	(0.78-3.47)	.193
Unsentenced, 14-59 days	2.69	(1.25-5.81)	.012	2.69	(1.29-5.61)	.008
60+ days	ref.					
Prison for public order offences, in pregnancy						
Yes	2.92	(1.47-5.80)	.002	3.00	(1.57-5.73)	.001
No	ref.					
Timing of first prison reception						
First reception prior to pregnancy start date	2.37	(1.09-5.16)	.030	2.56	(1.22-5.36)	.013
Second or third trimester (4-9 months)	1.28	(0.83-1.97)	.270	1.37	(0.89-2.10)	.147
First trimester (0-3 months)	ref.					
Prison for justice procedures, before birth						
Yes	1.62	(1.05-2.51)	.030	1.65	(1.08-2.51)	.020
No	ref.					
External injury hospitalisation in pregnancy						
Yes	1.70	(1.02-2.84)	.040	1.68	(1.02-2.78)	.042
No	ref.					
Prison for theft offences, in pregnancy						
Yes	1.55	(0.94-2.53)	.084	1.56	(1.00-2.43)	.050
No	ref.					
Sibling contact Child Protection in pregnancy						
Firstborn	1.18	(0.73-1.90)	.530	1.02	(0.65-1.62)	.923
Yes	0.54	(0.28-1.03)	.060	0.52	(0.28-0.97)	.040
No	ref.					
Remoteness						
Outer Regional	1.01	(0.61-1.69)	.963			
Remote/Very Remote	1.40	(0.82-2.40)	.222			
Major Cities & Inner Regional	ref.					
Previous abortion						
Yes	1.43	(0.89-2.31)	.141			
No	ref.					
Sex						
Male	1.28	(0.85-1.94)	.233			
Female	ref.					
Mental health service contact in pregnancy						
Yes	1.07	(0.52-2.20)	.856			
No	ref.					
Number of prison records in pregnancy						
1	1.16	(0.64-2.11)	.617			
2+	ref.					
Prison for traffic offences, before birth						
Yes	1.09	(0.65-1.84)	.732			
No	ref.					
Infection related hospitalisation in pregnancy						
Yes	1.01	(0.55-1.85)	.978			
No	ref.					
Prison for offences against the person, before birth						
Yes	0.71	(0.47-1.08)	.113			
No	ref.					

Model Fit and Predictive Ability	Model 1	Model 2
Observations	679	683
Log pseudolikelihood	-302.42	-308.41
AIC	1.006	0.968
Goodness-of-Fit (Pearson)	0.2124	0.0549
Goodness-of-Fit (Hosmer-Lemeshow)	0.6453	0.2660
Sensitivity	8.46%	6.87%
Specificity	98.18%	98.73%
Positive Predictive Value	52.38%	56.25%
Negative Predictive Value	81.91%	81.71%
False positive for those classified positive	47.62%	43.75%
False negative for those classified negative	18.09%	18.29%
Correctly identified	81.00%	81.11%
ROC	0.7009	0.6830
Condition index	20.00	12.88

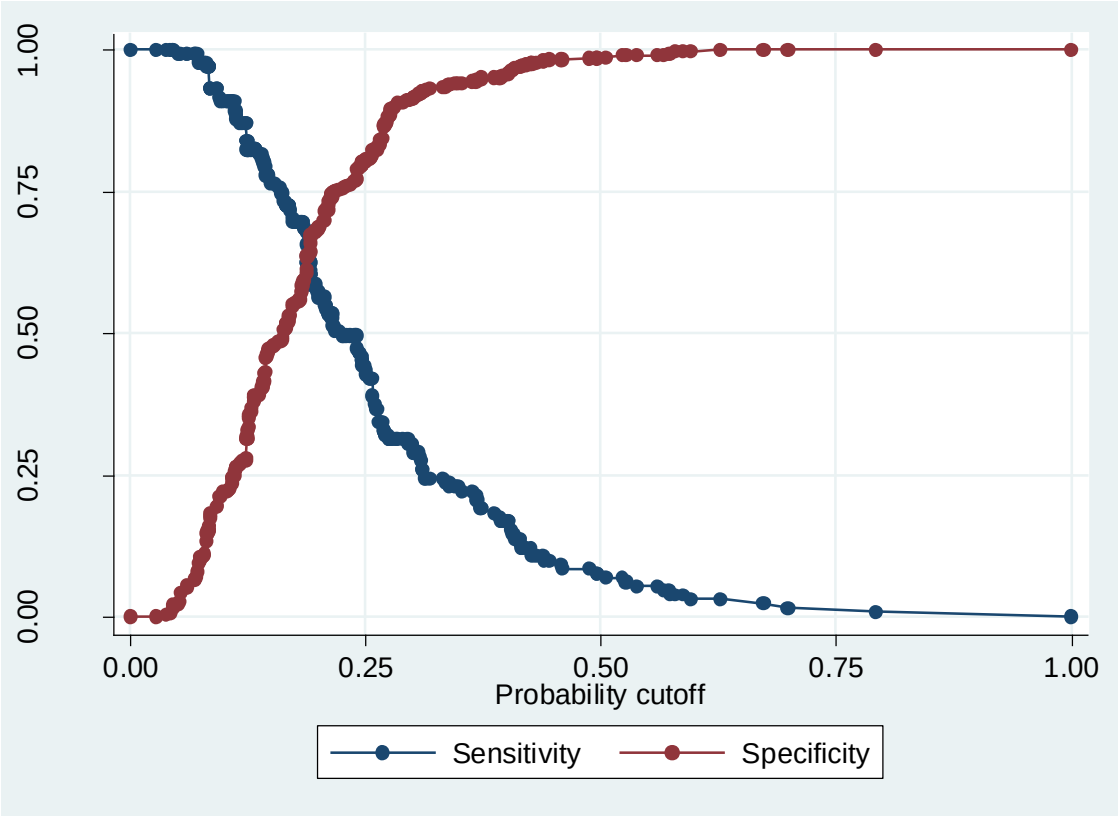
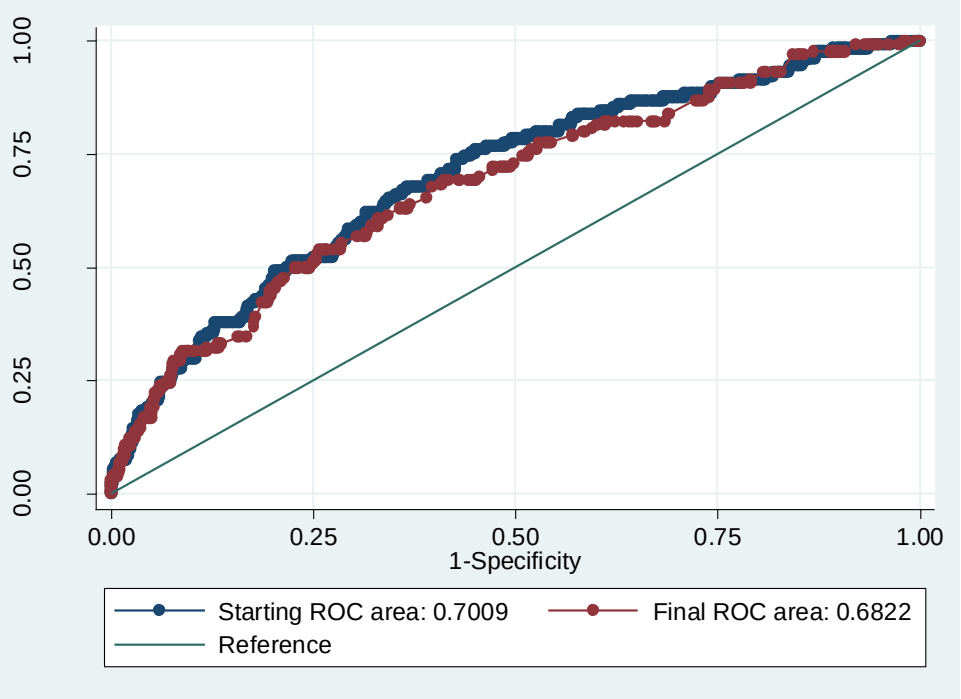


Figure 9.1 Sensitivity and specificity of Model 2

The discrimination of the final model was poor for predicting low birth weight, as measured by the area under the ROC curve. Overall there was no statistical difference between the two ROC areas of Models 1 and 2, χ^2 (1, N= 679) = 3.43, p=0.0641, as shown in Figure 9.2.



	Obs.	ROC Area	St. Err.	(95% CI)
Model 1: Starting	679	0.7009	0.0257	(0.65044, 0.75133)
Model 2: Final	679	0.6822	0.0264	(0.63043, 0.73404)

Figure 9.2 Comparison of ROC curves for Models 1 and 2

The reliability of the predicted values of for low birth weight within the final predictive model was below 0.26 (Figure 9.3).

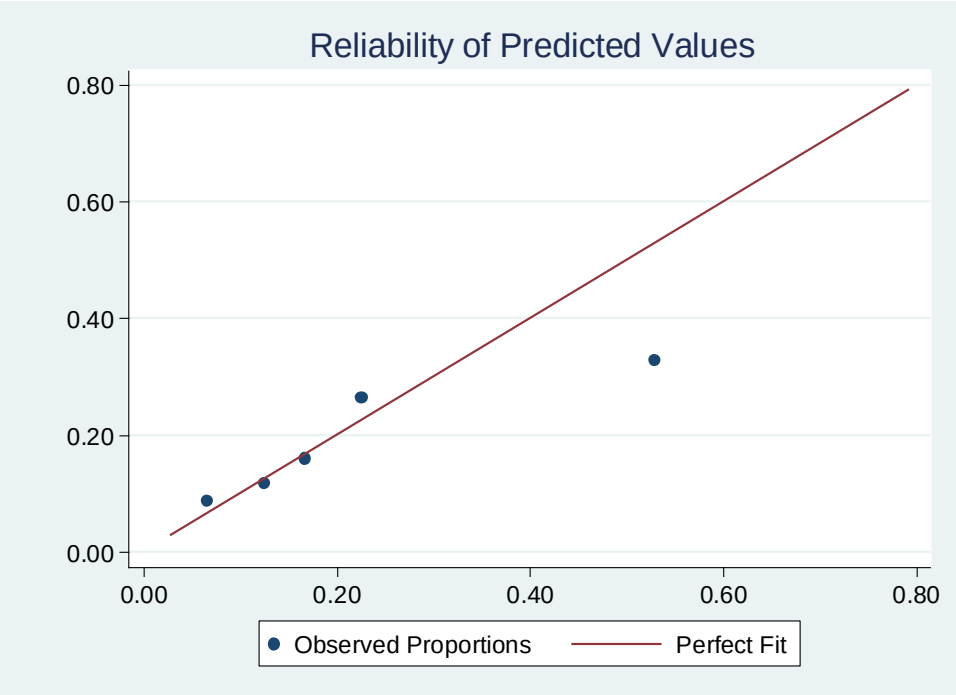


Figure 9.3 Predicted risks for low birth weight divided into 5 equal size groups, Model 2

The probability of low birth weight for infants by each of the characteristics within the predictive model, adjusted for all other variables in the model is shown in Table 9.3. The highest adjusted probabilities of low birth weight were found for infants with premature rupture of membranes, maternal imprisonment for public order offences in pregnancy, first maternal imprisonment reception in pregnancy starting preconception, and longest maternal imprisonment in pregnancy being for less than 14 days as an unsentenced prisoner.

Table 9.3 Probabilities of low birth weight for each predictor adjusted for other variables

Predictor variables	Adj. prob.	(95% CI)	*p*-value
Premature rupture of membranes			.0019
Yes	0.395	(0.249, 0.563)	
No	0.170	(0.142, 0.202)	
Prison record for public order offences, in pregnancy			.0082
Yes	0.330	(0.213, 0.473)	
No	0.168	(0.140, 0.201)	
Sentence type/length longest record in pregnancy			.0089
Sentenced (incl. default of fine), 1-13 days	0.186	(0.135, 0.251)	
Unsentenced, 1-13 days	0.254	(0.186, 0.337)	
Sentenced (incl. default of fine), 14-59 days	0.169	(0.109, 0.255)	
Unsentenced, 14-59 days	0.223	(0.143, 0.330)	
60+ days	0.100	(0.063, 0.156)	
Timing of first prison reception			.0875
First reception prior to pregnancy start date	0.274	(0.168, 0.412)	
Second or third trimester (4-9 months)	0.149	(0.113, 0.195)	
First trimester (0-3 months)	0.191	(0.151, 0.239)	
External injury hospitalisation in pregnancy			.0664
Yes	0.246	(0.172, 0.339)	
No	0.168	(0.139, 0.202)	
Prison record breach of justice procedures, before birth			.0565
Yes	0.216	(0.170, 0.271)	
No	0.157	(0.124, 0.197)	
Prison record for theft offences, in pregnancy			.0259
Yes	0.229	(0.178, 0.290)	
No	0.154	(0.121, 0.193)	
Sibling contact with Child Protection in pregnancy			.2103
Firstborn	0.197	(0.146, 0.260)	
Yes	0.121	(0.072, 0.199)	
No	0.187	(0.150, 0.231)	

9.5 Discussion

To our knowledge, this is the first study to consider whether factors such as offence type or other characteristics of mother's corrections records, predict low birth weight or infant mortality as pregnancy outcomes. Similarly, to our knowledge, this is the first attempt to develop predictive models of infant mortality and low birth weight for Aboriginal infants whose mothers were imprisoned during pregnancy. Several important risk factors related to maternal corrections contact were identified.

Within the literature, the characteristics of maternal imprisonment during pregnancy that have been considered as having a potential impact on birth outcomes include duration, timing and frequency of imprisonment.[6-8]

Martin et al[8] and Bell et al[6] found birth weight increased as the number of days mothers were imprisoned during pregnancy increased. Howard et al[7] reported maternal imprisonment only within the first trimester was associated with higher birth weight. In that study, however, all mothers were imprisoned for the remainder of their pregnancy and delivered in prison and so timing was also a measure of duration of imprisonment in pregnancy. Bell et al[6] included 'jail stays' of shorter durations within pregnancy (range 1-254 days, median 14 days) and did not find any association between trimester of imprisonment and either birth weight or pre-term birth.

In our study, one of the strongest predictors of low birth weight and infant mortality was short-term maternal prison stays during pregnancy. Infants whose mothers were imprisoned for less than two-weeks as sentenced offenders had the highest risk of infant mortality. For low birth weight, infants whose mothers were imprisoned for less than two months during pregnancy, particularly as unsentenced offenders on remand, were at the highest risk. This finding suggests a need for consideration of very short-term imprisonments of mothers as a high-priority issue within the Western Australian criminal justice system. A full discussion of the policy implications stemming from findings will be considered in the following chapter.

With respect to timing of imprisonment in pregnancy, we found infants whose mothers were first imprisoned in the preconception period had a significantly higher risk of low birth weight relative to infants whose mothers were first imprisoned in pregnancy in the first trimester. Maternal stress within the six-month period before conception has been

shown to increase the risk of poor infant outcomes.[9, 10] While infants born to mothers imprisoned in the first trimester experienced the highest rates of infant mortality, the association with infant mortality was not significant. Being born in prison was associated with a lower likelihood of low birth weight in univariate analysis but was highly correlated with increased duration of imprisonment in pregnancy and so was excluded from the predictive model.

We did not find an association with frequency of imprisonments during pregnancy and infant mortality or low birth weight. Bell et al[6] is the only other study that has considered the impact of frequency of imprisonments during pregnancy on birth outcomes. They found that women who were imprisoned more than three times during pregnancy had infants with lower birth weight. In our study only a small portion of our sample had mothers imprisoned three or more times during pregnancy (<5%), and we found that this group had a lower proportion of low birth weight than infants whose mothers were imprisoned once or twice in pregnancy. Within our sample, infants whose mothers were imprisoned three or more times during pregnancy had a higher number of pregnancy days in prison (Mdn=86), compared to infants whose mothers were imprisoned once or twice in pregnancy (Mdn=10), U= −5.411, p<0.0001.

A maternal corrections record for drug offences before birth was associated with reduced odds of both low birth weight and infant mortality, although the association was not significant for infant mortality, and relatively small numbers of Aboriginal mothers are imprisoned for drug offences. One possibility is that having a history of drug offences contributes to receiving a longer sentence in pregnancy. Infants whose mothers had a corrections record for drug offences before birth had a higher number of pregnancy days in prison (Mdn=26), compared to infants whose mothers had no corrections record for drug offences before birth (Mdn=11), U= −3.02, p<0.003. Similarly, maternal imprisonment for offences against the person before birth was also protective for low birth weight. It is also possible that mothers with a history of violent offences prior to pregnancy receive longer sentences, even for non-violence offences, within pregnancy. Within the sample, infants whose mothers had a prison record for offences against the person before birth had a higher number of pregnancy days in prison (Mdn=22), compared to infants whose mothers had no prison record for offences against the person before birth (Mdn=9), U= −4.72, p<0.0001. As previously reported

and as found in the present study, longer prison stays during pregnancy are generally associated with increased birth weight.

A notable difference between the low birth weight and infant mortality outcomes was that maternal imprisonment for theft offences in pregnancy was a risk factor for low birth weight in the multivariate predictive model but protective of infant mortality at the univariate level. This requires further exploration, but one possibility is that many theft offences are related to maternal drug use.[11] Imprisonment in pregnancy for theft-related offences may indicate problematic drug use or poverty, around the time of pregnancy and within the prenatal environment. Within the sample, infants whose mothers had a prison record for theft offences during pregnancy had a higher number of pregnancy days in prison (Mdn=24), compared to infants whose mothers were not imprisoned for theft offences in pregnancy (Mdn=11), U= −4.78, $p<0.0001$. This may explain why a prison record for theft offences during pregnancy only became a significant risk factor for low birth weight within the multivariate model when combined with length of imprisonment in pregnancy. With respect to the protective association seen for a history of drug offences before birth and imprisonment for theft in pregnancy with infant mortality at the univariate level, it is not known if infants remained in the care of their mother after birth.

A history of maternal imprisonment before birth for breach of justice procedures was also a significant risk factor for infant mortality and low birth weight, and imprisonment for public order offences during pregnancy was a significant risk factor for low birth weight. These offences in general attract shorter sentences, which is found to be strong predictor of both outcomes, but also may indicate a high level of socioeconomic disadvantage or household dysfunction due to the nature of offences within these categories, such as disorderly conduct, offensive language and behaviour, resisting arrest, or breaching the conditions of justice orders.

For infant mortality, but not low birth weight, having a last release type in pregnancy related to a ‘fine’ was a significant risk factor. It is likely these mothers were imprisoned for short periods in pregnancy, and the association with infant mortality may be explained by the high level of socioeconomic disadvantage or household dysfunction experienced by this sub-population of women prisoners. This requires further investigation.

Many of the non-corrections risk factors identified in the previous studies as being important determinants of infant mortality or low birth weight (reported in Chapters 7 and 8) were not significant predictors for infants whose mothers were imprisoned during pregnancy in this study. Previous studies included infants within the study sample who had different maternal corrections histories (including mothers who were imprisoned at times other than pregnancy, with community corrections only or no corrections records). Accordingly, these previous study samples were more heterogeneous than in the present study where it is likely that infants whose mothers are imprisoned during pregnancy share similar baseline characteristics related to maternal disadvantage.

Male sex and placental disorders were the only non-corrections factors which had a statistically significant univariate association with infant mortality. Within the predictive model of low birth weight only three factors were not related to maternal corrections contact; premature rupture of membranes, injury related hospitalisation in pregnancy and sibling contact with the child protection system in pregnancy.

Aboriginal infants with non-Aboriginal mothers who were imprisoned during pregnancy, had higher proportions of low birth weight and infant mortality than Aboriginal infants with Aboriginal mothers who were imprisoned in pregnancy although the relationship was not statistically significant, due to small numbers of Aboriginal infants with non-Aboriginal mothers within the study sample. In the studies of determinants of infant mortality and low birth weight (Chapters 7 and 8) for infants with varying exposures to maternal corrections history, Aboriginal infants with non-Aboriginal mothers overall had lower risks of infant mortality and low birth weight in the entire sample. Although there were small numbers of Aboriginal infants with non-Aboriginal mothers within the pregnant prisoner subsample, this is an interesting finding and warrants consideration in future research.

Overall the prediction model of low birth weight had poor discrimination and low sensitivity. Although a reliable prediction model was not able to be developed with the available data in the present study, the approach taken to develop the prediction model may be valuable for future studies. The potential benefits of being able to develop a predictive model utilising administrative data include being able to identify and target

high-risk women and mothers at early stages in pregnancy when they come into contact with services.

9.5.1 Limitations

As gestational age was not available and birth date was as month of birth only, pregnancy was taken to begin nine-months prior to month of birth for all infants. Accordingly, some records of exposure (including imprisonment) that were attributed to having occurred during pregnancy may have occurred prior to pregnancy if gestation was shorter than nine-months.

In using administrative data and only having primary diagnosis codes for key service contacts (not co-diagnoses), the study has not fully captured heavy drinking or substance use in pregnancy, mental illness, or injuries indicative of domestic violence in pregnancy within the study population. Accordingly, the findings linked to these factors relate to severe, acute events resulting in hospitalisation or mental health service contact.

It was not known which infants remained in the care of their mothers after birth, either in prison or the community. This is particularly important for a full understanding of infant mortality risk.

9.6 Conclusion

This study identified several characteristics of maternal corrections records that were associated with infant mortality and low birth weight. The predictive model developed was not able to predict infants at high risk of low birth weight reliably, and predictive analysis was not possible for infant mortality due to the low numbers of observations of infant deaths. The policy implications of these findings will be discussed in the next and final chapter.

9.7 References

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10 Discussion

In this chapter I review the key findings reported in this thesis, and consider the major implications of these findings for future research and policy development.

10.1 Summary of the research program

10.1.1 Overview of the research aims and studies

The central aim of this thesis was to address the lack of available empirical evidence on the children of women prisoners, and to establish early life outcomes, including low birth weight and infant mortality, for Aboriginal and non-Aboriginal children.

Infant mortality and low birth weight were selected as specific outcome measures for the children of women prisoners. These measures are particularly relevant in the context of the Developmental Origins of Health and Disease (DOHAD) literature, which highlights the importance of optimal fetal growth and development for good health in later childhood and adult life. The two outcome measures were also able to be derived with accuracy from the datasets used in this research, and the cohort was sufficiently large to explore rare outcomes.

As highlighted in the introduction to this thesis the research objectives were met through five specific research aims and associated studies. Studies I and II addressed the lack of data available on the population of Australian children affected by the incarceration of their mother in childhood and infancy (Research Aims 1 and 2). Studies III-V aimed to determine whether maternal imprisonment during pregnancy is a risk factor for infant mortality and low birth weight (Research Aims 3 and 4) and also explored the characteristics of maternal corrections contact during pregnancy that were associated with increased risk of these outcomes for Aboriginal infants (Research Aim 5). A conceptual framework was developed based on existing literature to provide a

background to how demographic, social and biological factors may interact to contribute to the outcomes for the infants and children of pregnant women prisoners. The analyses within this thesis did not address the causation of the measured outcomes for the children of women prisoners. The research has, however, identified a number of important factors for consideration in future research on the causes of outcomes for children of incarcerated mothers. Regardless of causality, maternal imprisonment presents an opportunity for the identification of, and provision of assistance to, children and families at risk of poor outcomes which have both immediate and long-term intergenerational consequences for the children of women prisoners.

10.1.2 Key findings of Studies I-V

Study I: Prevalence study of Western Australian children of women prisoners

- On average 1,544 children (aged 0-17 years) per year are affected by maternal imprisonment in Western Australia.
- Childhood prevalence of maternal imprisonment was significantly higher for Aboriginal children, with close to 1 in 5 (18.8%) Aboriginal children affected by the imprisonment of their mother at least once during childhood from birth to their 18th-birthday, compared to 1 in 140 (0.7%) non-Aboriginal children.
- There were nearly twice the number of Aboriginal as non-Aboriginal children affected by maternal incarceration in childhood.
- Approximately 6 in 10 maternal prison stays were for periods of 30 days or less.
- A significant proportion of children were first exposed to maternal imprisonment at young ages, with 45% of Aboriginal and 35% of non-Aboriginal children who were exposed to maternal incarceration in childhood, being first exposed when less than 5years of age.

Study II: Descriptive study of infant children of women prisoners in Western Australia

- Similar to the findings for children aged 0-18 years above, twice the number of Aboriginal as non-Aboriginal infants (0-1 years) were affected by maternal incarceration.

- Approximately 6 in 10 maternal prison stays were for a period of 30 days or less, with nearly 5 in 10 being for a period of 14 days or less.

- Nearly 1 in 3 (30.2%) Aboriginal infants and 1 in 4 (26.8%) non-Aboriginal infants who were exposed to maternal incarceration in infancy, were *also* exposed to maternal incarceration during pregnancy.

- Approximately 6% of Aboriginal and 4% of non-Aboriginal women prisoners were pregnant while imprisoned.

- Half of the children with a history of maternal imprisonment in pregnancy or infancy came into contact with child protection services by their second birthday, and approximately 1 in 3 Aboriginal (31%) and non-Aboriginal (35%) children were placed in out-of-home care in infancy.

- Placements in care during infancy were significantly higher for children with a history of maternal imprisonment in pregnancy or infancy, compared to children with no maternal history of corrections involvement at any time (27 times the rate for Aboriginal children and 110 times for non-Aboriginal children).

- Infant mortality for Aboriginal and non-Aboriginal children whose mothers were imprisoned up to 5-years before or one-year after birth, was double the rate of infant mortality for children with no maternal history of corrections involvement at any time.

Study III: Determinants of infant mortality for children of women prisoners

- For Aboriginal infants, infant mortality rates were highest for infants whose mothers were imprisoned during pregnancy (32.1 deaths per 1000 singleton livebirths), compared to infants of mothers imprisoned before pregnancy (22.1 per 1000) or after birth (23.6 per 1000), or whose mothers only had community corrections orders (16.5 per 1000), with the lowest mortality rate in children whose mothers with no corrections record (11.3 per 1000).

- Maternal imprisonment during pregnancy remained a strong determinant of infant mortality for Aboriginal children after adjusting for other significant pregnancy risk factors. Maternal imprisonment before pregnancy and after birth, and maternal community-corrections involvement, were also significant risk

factors for infant mortality for Aboriginal infants, compared to infants whose mothers had no corrections record.

- For non-Aboriginal infants, all study subgroups with any maternal corrections history had higher infant mortality rates (range 8.2-14.2 deaths per 1000 singleton livebirths), compared to infants with no maternal corrections record at any time (4.2 per 1000). There was a low incidence of infant deaths (n<5) in the non-Aboriginal sample, which limited the investigation of the relationship between maternal corrections exposure in pregnancy and infant mortality.

- For non-Aboriginal infants, the prevalence of infants born to mothers residing in the lowest 5% of areas by socioeconomic status, was significantly higher for the study subgroups with any maternal corrections history (range 12-14%), compared to infants whose mothers had no corrections record at any time (4%). Prevalence of very low socioeconomic status for was higher for Aboriginal infants, and there was no difference in the prevalence of low socioeconomic status between subgroups with any maternal corrections history (range 22-30%), and infants whose mothers had no corrections record (26%).

- Infants whose mothers were imprisoned before or during pregnancy had a significantly higher prevalence of pregnancy risk factors related to maternal adversity, including alcohol and other substance use, mental health, injury, and sibling contact with the child protection system, compared to infants whose mothers were first imprisoned after birth, only had community-based corrections orders, or no corrections records, for both the Aboriginal and non-Aboriginal study populations.

Study IV: Determinants of low birth weight for children of women prisoners

- For Aboriginal and non-Aboriginal infants, low birth weight was highest amongst infants whose mothers were imprisoned before or during pregnancy (20.4% and 20.2% of Aboriginal infants, and 14.4% and 11.8% of non-Aboriginal infants, respectively), compared to infants whose mothers were first imprisoned after birth, had only community-based corrections orders or no corrections record (15.1%, 12.8% and 9.3% of Aboriginal infants, and 9.4%, 7.2% and 4.4% of non-Aboriginal infants, respectively).

- After adjusting for other significant pregnancy risk factors, any maternal corrections history was a significant determinant of low birth weight compared to no maternal corrections record, for all infants. For Aboriginal and non-Aboriginal infants, maternal imprisonment before or during pregnancy had the strongest relationship with low birth weight, compared to imprisonment after birth or community-corrections orders. For non-Aboriginal infants, however, maternal imprisonment during pregnancy had wide confidence bands which overlapped those for maternal imprisonment after birth and maternal community-corrections orders.

Study V: Maternal corrections history and predictors of low birth weight and infant mortality for Aboriginal infants of mothers imprisoned in pregnancy

- The maternal corrections contact factors with the strongest relationship with low birth weight, after adjusting for other significant pregnancy risks, were: mother's longest record of imprisonment in pregnancy being unsentenced and for less than 60 days; imprisonment for public order offences during pregnancy; timing of first prison reception in pregnancy starting in the pre-conception period; and having a history of imprisonment for breach of justice procedures before birth.
- The maternal corrections factors with the strongest univariate relationships with infant mortality were: mother's longest record of imprisonment in pregnancy being sentenced (particularly for fine default) and for less than 14 days; mother's last prison release type in pregnancy was 'fine paid/fined ex-court'; mother imprisoned for fraud offences before birth; and mother imprisoned for breach of justice procedures in pregnancy.
- Nearly 1 in 4 (23.5%) Aboriginal children with mothers imprisoned in pregnancy for a period of less than two-weeks were born at low birth weight, and nearly 1 in 20 (4.7%) died in infancy (equivalent to infant mortality rate of 47 deaths per 1000 livebirths).
- Aboriginal infants whose mothers were sentenced (as opposed to unsentenced/remand prisoners) for periods of less than two-weeks in pregnancy experienced high infant mortality at 7% (or 70 deaths per 1000 live births). The majority of those infant deaths (12/14) had mothers who were sentenced for default of fine.

- For Aboriginal infants whose mothers were imprisoned during pregnancy and released with a fine, 13% died (131 deaths per 1000 livebirths) and one-quarter of these infants were born at low birth weight.

- Over 1 in 3 Aboriginal infants with a maternal prison record in pregnancy for public order offences were born at low birth weight.

10.2 Major implications of key research findings

10.2.1 The vulnerability of Aboriginal infants and children of women prisoners

No prior Australian studies have investigated maternal incarceration as a risk factor for infant mortality and low birth weight separately for Aboriginal and non-Aboriginal children. Importantly nearly 1 in 5 Aboriginal children experience the incarceration of their mother at least once during their childhood and the results presented in this thesis are therefore particularly important. Aboriginal infants whose mothers had contact with the corrections system, had a significantly higher prevalence of poor infant outcomes than Aboriginal infants whose mothers had no history of corrections involvement.

This study was not able to investigate the causes or contributors to these poor outcomes; contextual and historical influences were not accounted for in the study. It is known that Aboriginal mothers face potential discrimination in service contacts, notably within the justice and health sectors, which may have flow on impacts to children. Aboriginal mothers may also have concerns about accessing services for fear of removal of their children.[1, 2] These factors may be some of the many potential barriers to service access, which should be explored through further quantitative and qualitative research.

The findings in this thesis clearly highlight the vulnerability of Aboriginal children of women prisoners, particularly infants whose mothers are imprisoned before and during pregnancy, and the strength of these findings establish a high level of need for targeted policy and services for this population of children.

10.2.2 A history of maternal imprisonment, before, during and after pregnancy, as a risk factor for infant mortality and low birth weight

To our knowledge, prior to the research reported in this thesis there have been no studies which have comprehensively investigated infant mortality as an outcome for children whose mothers had a history of imprisonment. Similarly, while low birth

weight has been investigated as an outcome in studies of women prisoners in a small number of studies, the findings of the studies in this thesis established for the first time the level of these outcomes experienced by infants born to mothers imprisoned during pregnancy relative to periods before or after pregnancy and relative to infants whose mothers had community-based corrections or no corrections history.

Infant mortality

For Aboriginal infants in the study any maternal corrections history was a risk factor for infant mortality. In addition, maternal imprisonment during pregnancy was an important determinant of infant mortality for Aboriginal infants, compared to infants whose mothers were imprisoned before pregnancy or after birth.

The most significant maternal corrections factor associated with mortality for Aboriginal infants whose mothers were imprisoned during pregnancy was short term imprisonment of periods for less than two weeks. A subgroup of particular importance, is those Aboriginal infants born to mothers imprisoned during pregnancy with a 'release type' related to the payment of a fine, who experienced extremely high infant mortality at 13% i.e. 131 deaths per 1000 livebirths. Another important subgroup were Aboriginal infants with mothers imprisoned during pregnancy for breach of justice procedures, at 56 deaths per 1000 livebirths. These subgroups of pregnant prisoners require further investigation, given the findings that their infants are at particular risk of poor pregnancy outcomes. It would be important to investigate in future studies whether it is the impact of the payment of the fine, or specific characteristics of the offender which contribute to these poor outcomes.

Infant mortality is a measure which includes the period up to 12-months of age, and it is possible that factors which occur after pregnancy including the period after the release of the mother from prison contribute to infant mortality outcomes. This signals that an important area for future research is the investigation of the factors which contribute to timing of infant death for Aboriginal infants whose mothers were imprisoned during pregnancy.

Independently of the findings of future studies, the findings from the studies presented in this thesis highlight the need for targeted support for pregnant prisoners during pregnancy, following the birth of their infants, and through the first year of life to reduce infant mortality.

Low birth weight

For low birth weight as an outcome, it was found that Aboriginal and non-Aboriginal infants whose mothers were imprisoned before or during pregnancy had a higher prevalence of low birth weight relative to infants whose mothers were first imprisoned after birth. Notably Aboriginal infants whose mothers were imprisoned in the pre-conception period (i.e. <6 months before conception) were at increased risk of low birth weight and one-quarter of these infants were low birth weight. Infants whose mothers were imprisoned before or during pregnancy also had a higher prevalence of pregnancy risk factors related to maternal vulnerability, including alcohol and other substance use, poor mental health and increase in injury, when compared with those infants of mothers whose first imprisonment occurred after their birth.

The most significant maternal corrections factor associated with low birth weight outcomes for Aboriginal infants with mothers imprisoned during pregnancy was short term imprisonment of periods for less than two months for low birth weight. In contrast to infant mortality, Aboriginal infants whose mother had a prison record in pregnancy for public order offences experienced the highest rate of low birth weight at over 1 in 3 infants.

The analyses within the thesis have not determined whether short-term imprisonment is causal of infant mortality and low birth weight or if the increased risk of these outcomes is mainly contributed to by other disadvantage factors experienced by the mother. It is theoretically possible that short-term imprisonment may exacerbate maternal disadvantage and have a separate effect on infant outcomes, perhaps through mechanisms such as increased maternal stress as considered in the DOHAD literature.[3-7] Future research should investigate whether outcomes for infants whose mothers are imprisoned for short terms in pregnancy differ from infants whose mothers are given a community sentence during pregnancy. It would be difficult, however, to explore these differences given the different nature of offending and histories of offenders that are relevant to sentencing decisions. Another possible method of investigation would be to match infants on or control for maternal risk profiles and timing of risk exposures (such as maternal alcohol and substance use, mental health, and domestic violence), with only one group being exposed to short-term maternal imprisonment in pregnancy.

The strength of the findings that infants whose mothers are imprisoned for short-terms during pregnancy experience high levels of low birth weight and infant mortality, highlights the particular vulnerability of this subgroup within the prisoner population and that there should be targeted services provided for this population as a priority.

Summary

Our findings highlight the potential interaction between the timing and length of imprisonment in relation to pregnancy and the experience of maternal adversity on poor outcomes for the infants of women prisoners. This is in line with the proposed Conceptual Framework proposed in Chapter 3 which highlights the impact of exposure of the developing embryo or fetus to the biological effects of maternal adversity and stress during this key developmental period. It is not known, however, which of the factors that contribute to maternal offending or relate to imprisonment lead to maternal stress and poor infant outcomes.

Further research is required to identify the specific impact of single or cumulative experiences of maternal adversity, including short prison stays and the interaction of these experiences with the timing of imprisonment, before and during pregnancy on those pregnancy risk factors which impact on fetal growth and contribute to the outcome of low birth weight, and infant mortality. While further research is required it is the case that the work in this thesis has identified high-risk subgroups who should be targeted for service support as a priority.

10.3 Limitations

The limitations related to the particular research studies have been discussed in their corresponding chapters, including the limitations of the sampling of the study population in Chapter 4. In this section, the limitations related to the overall research program are discussed.

10.3.1 Linked administrative data

Despite the many benefits of utilising linked administrative data, such as the ability measure rare outcomes, there are several inherent limitations. In utilising linked administrative data it is possible for record errors including incorrect entries, being either missed or wrongly attributed, in part or in full. The WADLS is the longest

operating data linkage system in Australia and systematically includes data quality checks and measures.

In utilising linked administrative data, the project data is limited to records of service contacts. Accordingly, it was not possible to capture all risk factors related pregnancy outcomes, such as maternal alcohol and substance use or intimate partner violence.

10.3.2 Details of caregivers

It was not possible within the present study to account for the caregiving status of mothers at the time of their imprisonment, nor was it possible to include fathers or maternal partners in the project. This is a limitation of the study, however, supporting survey evidence[8] suggests the majority of Western Australian women prisoners are caregivers to their children.

10.3.3 Birth date and gestational age

As birth date were obtained to month only, and gestational age was not obtained, this limited the accuracy with which the pregnancy period was identified. Pregnancy was defined as starting nine-months prior to month of birth for all infants. Accordingly, some records of exposure (including imprisonment) that were attributed to having occurred during pregnancy may have occurred prior to pregnancy if gestation was shorter than nine-months.

10.3.4 Generalisability of findings

The findings may not be generalisable to populations outside of Western Australia, given the importance of factors specific to the Western Australian criminal justice system such as the use of imprisonment for fine default, which differs between Australian jurisdictions, and the high level of short-term imprisonment, which limits comparisons with the international literature without the use of length of imprisonment as a covariate.

10.4 Implications for policy

The research in this thesis has provided a detailed description of the population of children, and infants, of women prisoners in Western Australia, and established their increased vulnerability with respect to important health (i.e. low birth weight and infant mortality) and social outcomes (i.e. contact with child protection services) in early life.

Infants born to pregnant prisoners are a high priority population who require targeted supports to improve their perinatal outcomes. Alternative sentencing options for pregnant offenders could be explored, such as participation in programs to support new mothers and address underlying disadvantage. Given small numbers of women are affected, this is a population who could be targeted effectively with reasonable resources. Justice reinvestment principles advocate for the efficient use of criminal justice resources in the community to prevent imprisonment. The potential benefits for such as program would be significant given the level of poor outcomes experienced by infants within this subpopulation, and the importance of outcomes in early life for determining long-term health and wellbeing.

The findings of the studies within this thesis highlight the particular importance of providing support to women imprisoned for short periods during pregnancy. Given that short imprisonment terms generally are given for relatively less serious offending, alternative sentencing options including rehabilitative programs and supervision within the community, should not conflict with the requirements for community safety.

There is an argument to be made for sentencing decisions to give greater consideration to the best interests of the (unborn) child in the sentencing of pregnant prisoners for particularly short-durations. Currently the potential impact of parental imprisonment on the child is considered in sentencing decisions in only "exceptional circumstances".[9]

The research has highlighted how maternal contact with government services, including prisons, hospitals, and mental health services, may provide important opportunities for identification of high risk pregnancies. A history of maternal imprisonment prior to pregnancy, and particularly during pregnancy, may be a useful marker for screening to enable greater maternal support through pregnancy and early childhood. This would need to be approached with cultural sensitivity given the high representation of Aboriginal women, and concerns regarding potential removal of children from families.

The findings in the thesis have highlighted the general need for a reorientation from thinking about women prisoners as women alone, to a greater focus on the potential impacts on the child and family when mothers are imprisoned. Western Australia has taken significant steps towards family-centred prison services through the establishment of the Boronia Pre-Release Centre for Women. The findings in this thesis highlight the importance of evaluation of the degree to which this model of care improves the

outcomes for children of women prisoners, given the high level and range of adversity experienced by prisoners who are mothers.

10.5 Future research directions

The research in this thesis has highlighted the wide variation in the nature of exposure of children and infants to maternal incarceration, and that risk of low birth weight and infant mortality varies considerably between infants whose mothers have had specific characteristics of contact with corrective services in pregnancy. This highlights that it is important in future research not to treat exposure to maternal imprisonment as a dichotomous variable, without consideration of the variations in the nature of exposure within the broader population of children of women prisoners. The findings also highlight that low birth weight and infant mortality outcomes for women prisoners likely have unique contributing factors, and that low birth weight may not always be a useful proxy for infant mortality.

The specific areas for future research include:

- Consideration of whether traditional offence categories which indicate the 'severity of offending' relate directly to maternal adversity and disadvantage
- Investigation of whether the severity of offending is as important as the length of maternal imprisonment for infant outcomes
- Investigation of the critical windows of the timing of maternal imprisonment before and during pregnancy and their relationship to low birth weight and infant mortality
- Investigation of timing of events in the period post-release of mothers from prison that may be particularly significant for infant mortality
- Determine whether outcomes for children differ for mothers with exposure to different prisons and different programs within the same prison environment.

Finally the result of this thesis highlight that it is now timely for research to focus on the cumulative or separate effects of maternal adversity and disadvantage experienced around the timing of imprisonment for child outcomes.

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Appendix A
Summary of adaptations of the Mosley and Chen (1984) framework

Six studies[1-6] were identified that directly utilised the Mosley and Chen[7] framework (Chapter 3, Figure 3.1), and a further two[8, 9] which, although not directly based on Mosley and Chen[7] (1984), shared similar approaches with Mosley and Chen[7] (1984). These frameworks are briefly described below.

Schell et al[2] and Sartorius and Sartorius[1] use conceptual frameworks, shown in Figure A1, that were adapted from the Mosley and Chen[7] framework. Schell et al[7] used the framework to study the relationship between *"major distal socioeconomic determinants and infant mortality rate"* using countries as units of observation. Schell et al[2] describe the conceptual framework as follows:

> "Infant or child deaths are seen as attributable to a range of hierarchical determinants … that may be proximal (e.g. infections and accidents), intermediate (e.g. electricity and sanitation), or distal (e.g. societal conditions measured in terms of socioeconomic achievements)."[2]

Sartorius and Sartorius[1] also used countries as units of observation, and adapted their model from the Schell et al[7] and Mosley and Chen[7] frameworks. These adaptions were developed for the purpose of investigating determinants of infant mortality at the broadest level, being between countries of observation, and are not directly relevant for our current research at the individual level. They also somewhat departed from the central tenet of the Mosley and Chen[7] framework i.e. that the proximate determinants represent an exhaustive list of the biological mechanisms through which broader determinants may act.

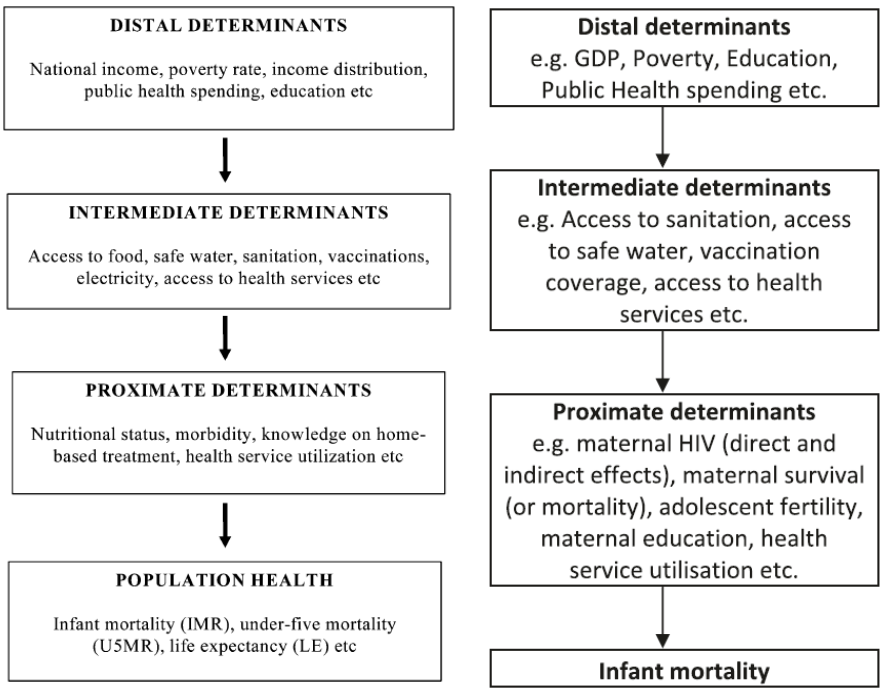


Figure A1 Schell et al[7] (left) and Sartorius and Sartorius[1] (right) conceptual frameworks adapted from Mosley and Chen[7]

Titaley et al[3] also adapted the Mosley and Chen[7] framework, in their study of the determinants of neonatal mortality in Indonesia. The structure of their framework, shown in Figure A2, is more in line with Mosley and Chen[7], but Titaley et al[3] have identified five different groupings of proximate determinants, i.e. those related to the mother (age), neonate (sex, birth size, birth rank, birth interval), and determinants by three time-points in relation to delivery: pre-delivery factors (desire for pregnancy), delivery factors (assistance, complications, mode, place), and post-delivery factors (post-natal care). These are closer to constituting "biological mechanisms" than those proximate determinants identified in Schell et al[7] and Sartorius and Sartorius[1]. Arguably, however, these groupings of proximate determinants may not be "exhaustive", given the breadth of the DOHAD research (Chapter 2) which includes a wider range of biological mechanisms including those related to intrauterine growth (with associated risk of mortality) through to the consequences of maternal stress. More obviously absent, in the Titaley[3] framework are factors which Mosley and Chen[7] considered to be broadly related to "environmental contamination" which can be extended to the impact of exposure to toxins in the intrauterine environment, including maternal alcohol and other substance consumption, as well as exposure to environmental pollution.

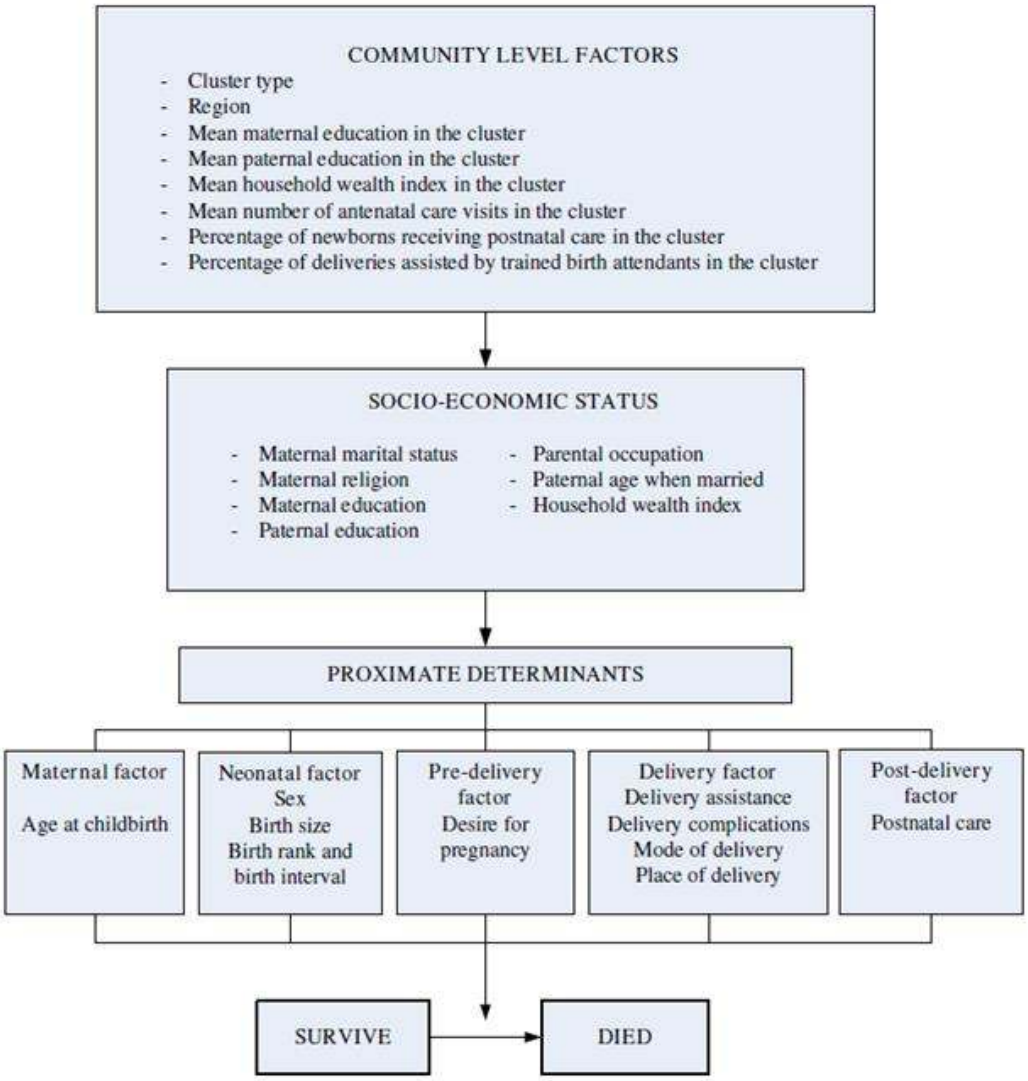


Figure A2 Titaley et al[3] conceptual framework for factors influencing neonatal mortality, adapted from Mosley and Chen[7]

Hanmer, Lensink and White[5] based their theoretical framework on Mosley and Chen[7] model, noting:

> The insight of this approach is that underlying socio-economic status (SES) manifests itself in (measureable) proximate determinants. The values of these variables influence the risk of disease, which link to the probability of death.[5]

The adaptation by Hanmer, Lensink and White[5], shown in Figure A3, is a simplified version of the Mosley and Chen[7] approach and includes the same five dimensions of proximate determinants.

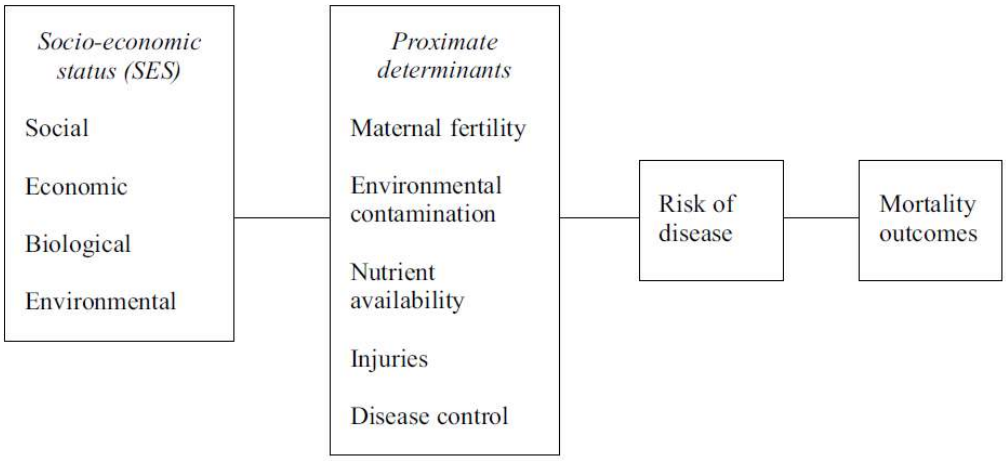


Figure A3 Hanmer, Lensink and White's[5] adaptation of Mosley and Chen's[7] framework

Myers[6] examined frameworks of child survival, growth and development, to better understand associated variables. Of the frameworks considered by Myers, the Mosley and Chen[7] (1984) framework is the only one that considered child survival as the main dependent variable. The other frameworks focussed more on child welfare, and social and psychological development, which was the focus of Myers'[6] work. Myers'[6] discussion of the Mosley-Chen[7] framework included the statement that:

> The purpose of the model presented by Mosley and Chen … is to aid the study of social, economic, biological, and environmental factors affecting the probability of survival. This epidemiological model is the work of two medical doctors with field experience in developing countries and with a strong public health bias. The model is particularly important for several reasons:
>
> 1. It represents a conscious, prudent, and influential effort to overcome communication barriers between medical and social science communities by seeking common ground, combining variables from the social science with medical variables in one operational model.
>
> 2. The model looks at survival (and death) as process(es) occurring in time and defined in terms of a health/sickness continuum. In so doing, the model redefines 'cause of death' as the cumulative consequence of multiple disease processes (including their biosocial interactions). Growth faltering is taken as an indicator of a child's general condition, with death incorporated as the end point of growth faltering.
>
> 3. Within the medical community, this is a revisionist model. By giving an important place to socioeconomic determinants of survival, it shifts analysis and action from extending and improving the supply of health technologies and services to working on the demand for technologies and services while strengthening the 'home production' of health.

> 4. By grouping 14 variables into a set of 5 'proximate' (intermediate) variables, Mosley and Chen arrive at a relatively parsimonious model in which socioeconomic determinants are seen to act through biological mechanisms to insert an influence on mortality.
>
> In brief, this is an integrative and broad, yet relatively tidy, analytical scheme marking an advance in thinking about child health and survival.[6]

Myers[6] adapted the model to incorporate child development into the framework by *"including psychological health and social adjustments as components of 'a healthy state'"* and incorporating *"a sixth 'proximate determinant' ... 'psychosocial stress'"*. As Myers[6] states:

> Along with nutrients and cleanliness, etc. a child needs loving, stimulating, reciprocal attention. Failure to receive such attention creates stress and can reduce activity, affecting where an individual is on the health-sickness-death continuum.[6]

It is noted that Myers'[6] considered 'reduced activity' as the likely mechanism for harm caused by 'psychosocial stress'. The subsequent DOHAD literature provides evidence of a potential biological mechanism through which psychosocial stress can harm the mother and child.[10-13]

Ezeh et al[4], utilised the Mosley-Chen[7] framework as follows:

> Study factors for this study were based on the Mosley and Chen framework of factors influencing child survival in developing countries; other previous studies on childhood mortality (particularly in the sub-Saharan Africa region) also played a role in the assessment of potential study variables. These variables were adapted to the data available in the merged data set and comprised geographic location of place of residence (categorised as urban-rural residence), a household measure of income and a range of individual-level factors. Individual-level factors consisted of maternal characteristics (religion, education, literacy level, age, body mass index, occupation and desire for pregnancy); child characteristics (sex, birth place, size, mode of delivery, delivery assistance, and a combination of birth order and birth interval) and paternal education. The only household-level factor used was the wealth index variable, which measured the economic status of the households interviewed in the survey.[4]

Matteson et al[8], although not based on Mosley and Chen[7], take a similar approach with a conceptual framework developed with two key components: Personal risk factors (Background risk factors; Proximate determinants), and Community factors (Health care environment; Community standard of living/economic vitality; Urbanization/population composition).

The framework developed by Kim and Saada[9], drew on the World Health Organization's Commission on Social Determinants of Health for their conceptual

framework.[14, 15] As with Matteson et al[8], although not based on Mosley and Chen[7], the Kim and Saada[9] framework shares similarities with respect to the broad study of Mosley and Chen[7]. As shown in Figure A4 and described by the authors as follows:

> As seen in this figure, the social determinants consist of the material living and working conditions and social environmental conditions in which people are born, live, work, and age, and the structural drivers of these conditions, comprised of individual and area level socioeconomic status (SES), race/ethnicity, residential segregation, gender, social capital/cohesion, and the macroeconomic and macrosocial context, e.g., macroeconomic and social policies including labour market regulations [28], political factors including governance and political rights [29,30], and culture. Macroeconomic determinants include the gross domestic product (GDP) per capita and income inequality. The broader macroeconomic and social context generates social stratification i.e., the sorting of people into dominant and subordinate SES, racial/ethnic, and gender groups (Figure 3). Through stratification and differential exposures of individuals to levels of material factors/social resources, social determinants such as individual/area level SES, race/ethnicity, and social capital shape individual level intermediary determinants, including behavioural factors (e.g., maternal smoking), biological factors, and psychosocial factors (e.g., social support), which in turn produce differential risks of, and inequities in, IM/birth outcomes.[9]

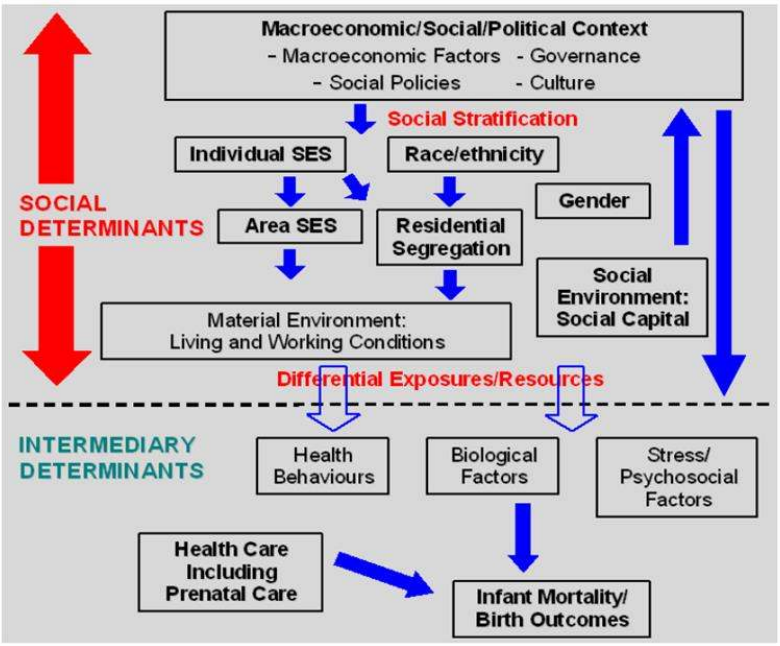


Figure A4 Kim and Saada[9] adaptation of the World Health Organization's Commission on Social Determinants of Health conceptual framework[14, 15]

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Appendix B Determination of mother birth date

Table B1 Determination of best available data for mothers' birth dates

Step	Description	Cohort mothers, n=3,858	Comparison mothers, n=22,040
1	Identify mothers who are also in the cohort or comparison groups (as children). Use their cohort/comparison birth registration or midwives DOB data.	202	647
2	Identify mothers with no DOB record across all data. Estimate DOB if possible in step 10.	0	41→*Step10*
3	Identify mothers with only one DOB used in a single dataset. Use that DOB.	0	4204
4	Identify mothers with only one DOB used across multiple datasets. Use that DOB.	2701	14861
For remaining mothers with inconsistent DOB records, assess inter- and intra-dataset consistency (n=955 cohort-mothers, n=2287 comparison-mothers)			
5	For mothers with a DOB used across all datasets (but other inconsistent date records). Use maternal age variable from children's midwives record to validate that DOB.	495	1616
6	For mothers with a DOB used across all datasets (but other inconsistent date records). Use maternal age (+/- 1year) to validate that DOB.	30	110
7	Select the DOB used across the most datasets and validate with maternal age from midwives (+/- 1 year)	368	320
8	For remaining mothers with multiple DOBs used across the same number of datasets, choose the date with the highest number of records. Validate with maternal age from midwives (+/- 1 year).	50	174
9	For remaining mothers with multiple DOBs, not resolved in above steps. Sort all DOB records per mother, select the earliest date that matches maternal age from midwives. Note. All were able to be validated within 1 year of maternal age from midwives.	12	67
10	Estimate approximate DOB for mothers with no record of DOB using maternal age from children's midwives if possible.	0	15
11	Mother missing birth date.	0	26

Appendix C Determination of SEIFA and ARIA

Table C1 Method of SEIFA determination developed and applied within thesis, using cohort (first-generation) as example

Step	Description	Sequence of Approach*	Cohort Allocated n (%)	Missing n (%)
1	CD level data from Midwives. If available for closest census to DOB.	Mid CD1	8114 (84.2)	1521 (15.8)
2	CD level data from Emergency (same PC as Mid). Earliest record with CD data and same PC as Mid. If available for closest census to DOB.	ED CD1	454 (4.7)	1067 (11.1)
3	CD level from Midwives/Emergency. Second closest census to DOB, then third closest census to DOB.	CD2-3	177 (1.8)	890 (9.2)
4	Mean of CD scores within each postcode by census and Indigenous status. Census closest to DOB, then second, then third.	CD mean 1-3	790 (8.2)	100 (1.0)
5	Postcode IRSD score for census closest to DOB.	PC1	29 (0.3)	71 (0.7)
6	SLA level from Midwives/Emergency. Census closest to DOB, then second, then third.	SLA1-3	21 (0.2)	50 (0.5)
7	LGA level from Midwives/Emergency. Census closest to DOB, then second, then third.	LGA1-3	0	50 (0.5)
8	CD level data from Emergency (first record after birth, different PC than Mid). Census closest to DOB, then second, then third.	ED2 CD1-3	24 (0.2)	26 (0.3)

***** **Numbers (1-3) refer to census order closest to participant's date of birth (DOB)**
CD **Collection District**
SLA **Statistical Local Area**
LGA **Local Government Area**
Mid **Midwives**
ED **Emergency Department**

Table C2 Illustrative example of alternative methods (Stand 1-3) of SEIFA determination, based on standard approach (Calver et a 2007)

Method	Description	Sequence of Approach*	Cohort Allocated (n)	Missing (%)
Stand1	Using only Midwives data. Approach prioritised SEIFA level (i.e. CD, SLA, LGA).	CD1-3 SLA1-3 LGA1-3	9088	5.7
Stand2	Using Midwives and Emergency Department data. Approach prioritised SEIFA level (i.e. CD, SLA, LGA).	CD1 Mid CD1 ED CD2-3 SLA1-3 LGA1-3	9266	3.8
Stand3	Using Midwives and Emergency Department data. Approach prioritised closest census to DOB (i.e. 1,2,3).	CD1 Mid CD1 ED SLA1 LGA1 CD2 SLA2 LGA2 CD3 SLA3 LGA3	9266	3.8

***** **Numbers (1-3) refer to census order closest to participants' date of birth (DOB)**
CD **Collection District**
SLA **Statistical Local Area**
LGA **Local Government Area**
Mid **Midwives**
ED **Emergency Department**

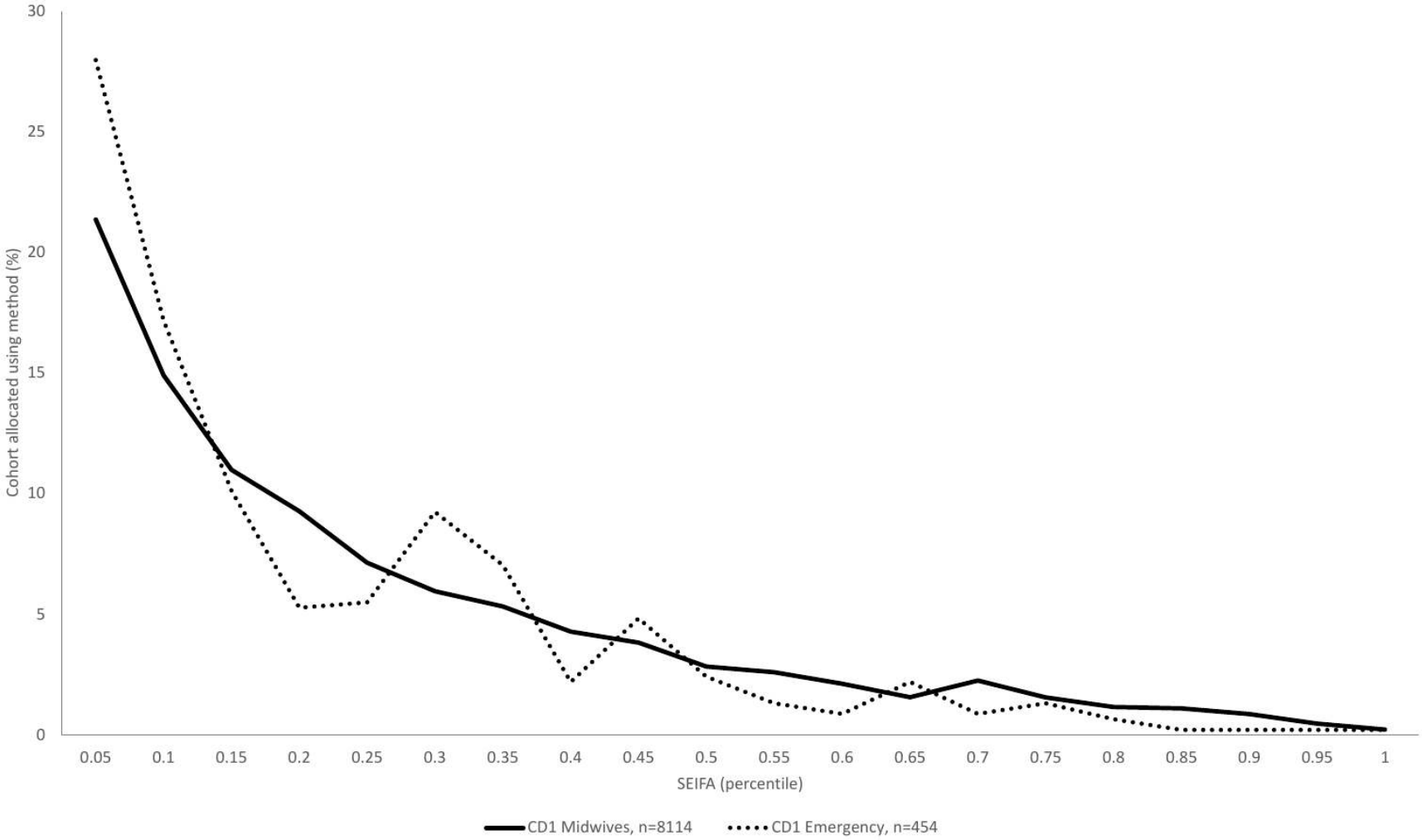


Figure C1 SEIFA distribution for cohort using Midwives and Emergency CD1 data

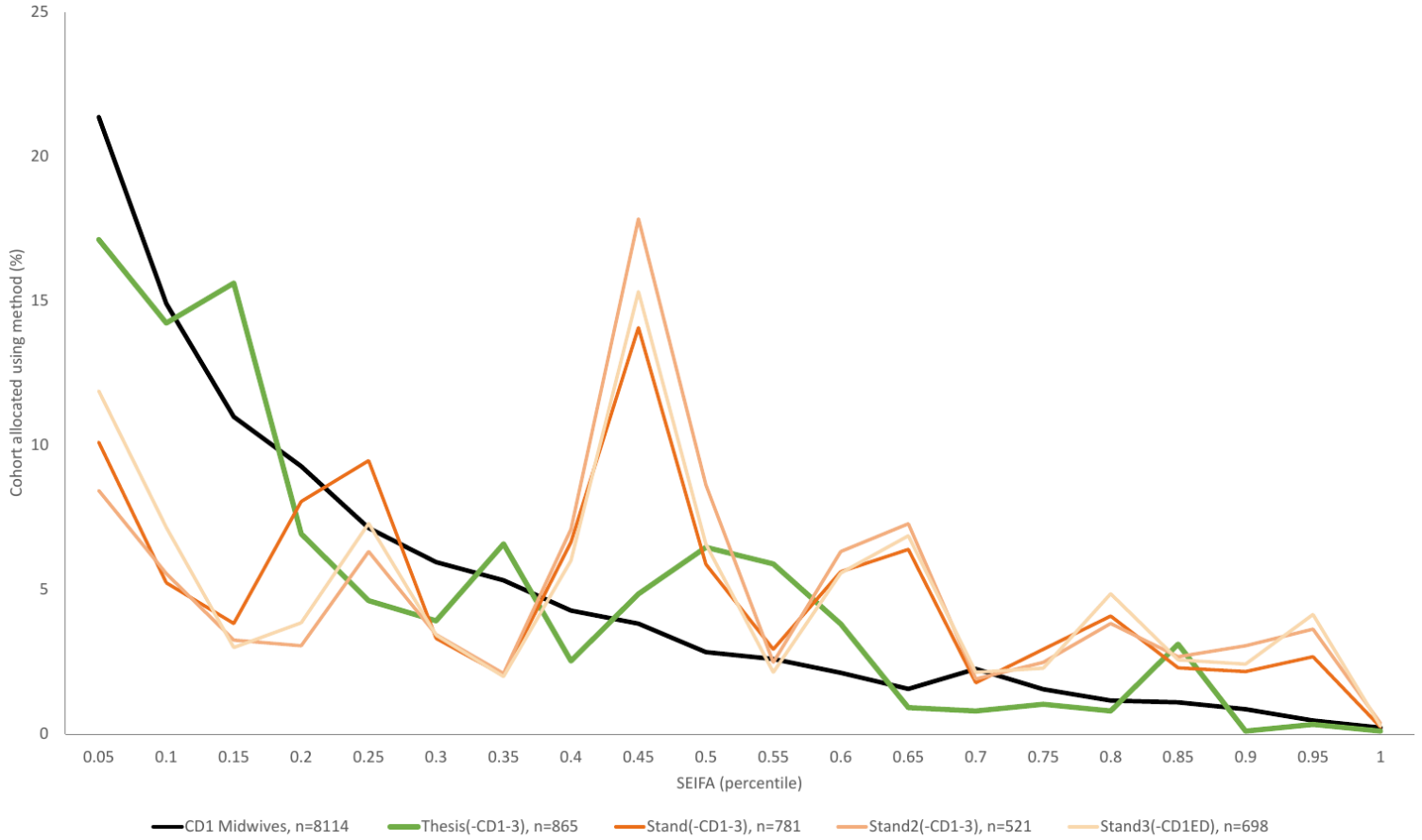


Figure C2 Comparison of SEIFA distributions for portions* of the cohort allocated by thesis method (green) and alternative methods (orange), compared to those allocated by best available CD-level data from the Midwives Notification System (black)

***Note: Thesis and alternative methods (Stand1-3) above only include the individuals allocated uniquely by that method i.e. All exclude individuals allocated at the CD1 Midwives and CD1 ED stages. Thesis and Stand1&2 also exclude individuals allocated by CD2-3 (equivalent of Step 3 in Table B1).**

Table C3 Remoteness approach, using cohort as an illustrative example

Step	Description	Sequence of Approach*	Cohort Allocated n (%)	Missing n (%)
1	CD level data from Midwives. If available for closest census to DOB.	Mid CD1	8114 (84.2)	1521 (15.8)
2	CD level data from Emergency (same PC as Mid). Earliest record with CD data and same PC as Mid. If available for closest census to DOB.	ED CD1	454 (4.7)	1067 (11.1)
3	CD level from Midwives/Emergency. Second closest census to DOB, then third closest census to DOB.	CD2-3	177 (1.8)	890 (9.2)
4	Median of CD scores within each postcode by census and Indigenous status. Census closest to DOB, then second, then third.	CD median 1-3	790 (8.2)	100 (1.0)
5	SLA level from Midwives/Emergency. Census closest to DOB, then second, then third.	SLA1-3	33 (0.3)	67 (0.7)
6	LGA level from Midwives/Emergency. Census closest to DOB, then second, then third.	LGA1-3	0	67 (0.7)
7	CD level from Emergency (first record after birth, different PC than Mid). Census closest to DOB, then second, then third.	ED2 CD1-3	36 (0.4)	31 (0.3)

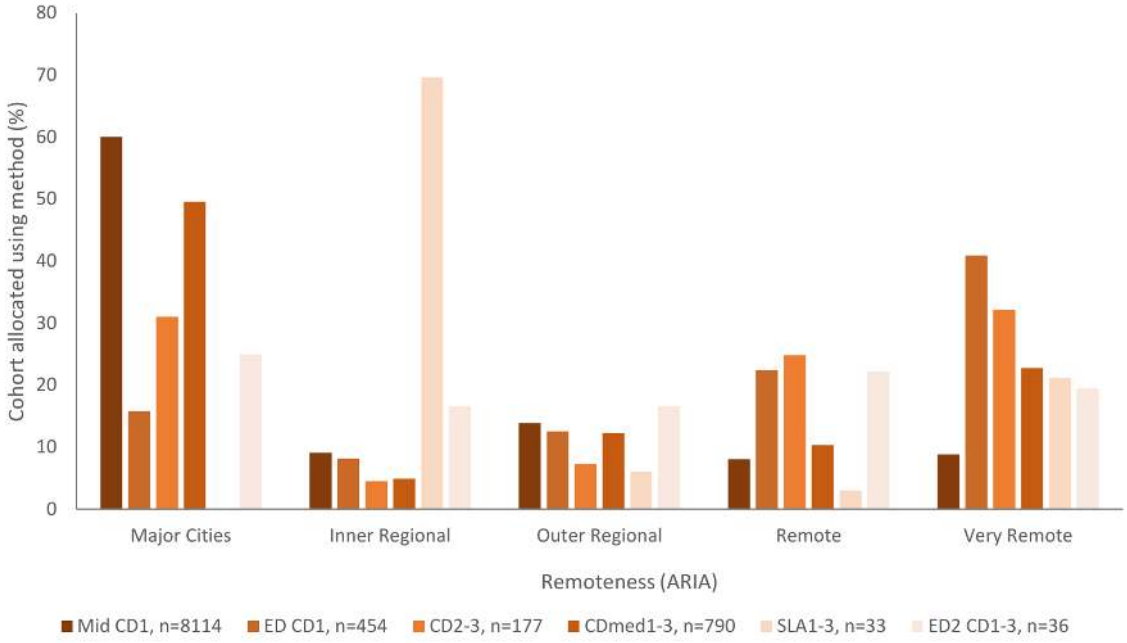


Figure C3 ARIA distribution by Steps 1-7 (excluding 6)

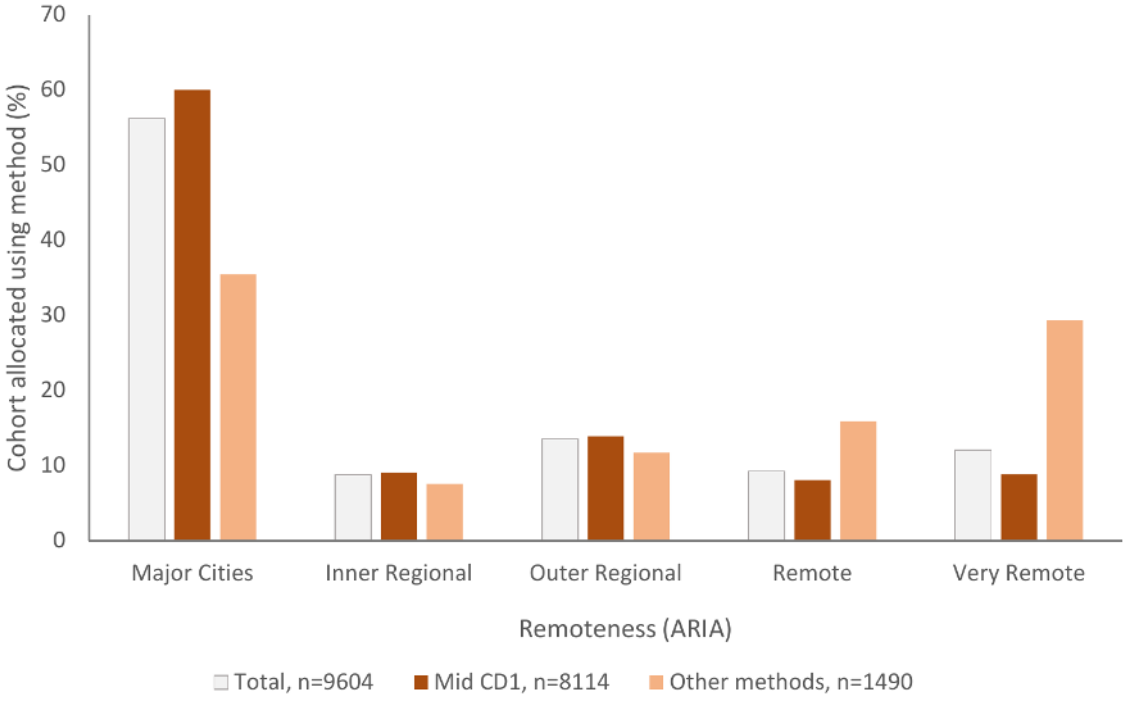


Figure C4 Total ARIA distribution, and for Step 1 and Steps 2-7

Interestingly, there was a notable difference between the ARIA distributions for the first-generation cohort with best available CD level data from the Midwives data, and

those who were missing best available CD level Midwives data but had CD level data available from the ED data for the closest census to their birthdate and with matching postcode to that stated in the Midwives data at time of birth (Appendix B Figure 3). More individuals were allocated in the ‘remote’ and ‘very remote’ categories using the ED data. Given the same postcode was used as recorded at time of birth in the Midwives data (and the census closest to date of birth was used) it is likely that these areas are determined accurately. It possibly suggests that individuals living in ‘remote’ and ‘very remote’ areas were less likely to have CD level recorded in the Midwives Notification System than on ED presentation.

Appendix D ICD codes used to define study variables

Table D1 ICD codes identified in data for chromosomal abnormalities

CHROMOSOMAL ABNORMALITIES			
Chapter	Diagnosis level 1	ICD ed.	ICD codes
Complications of pregnancy, childbirth, puerperium	Chromosomal anomalies	9	655.1
Congenital anomalies	Chromosomal anomalies	9	758
Pregnancy, childbirth and the puerperium	Maternal care for (suspected) chromosomal abnorm. in fetus	10	O35.1
Congenital malform., deform. and chromosomal ab.	Chromosomal abnormalities	10	Q90-Q99

Table D2 ICD codes identified in data for multiple gestation pregnancies

MULTIPLE GESTATION				
Chapter	Diagnosis level 1	Diagnosis 2	ICD ed.	ICD codes
Complications of pregnancy, etc.	Normal delivery, etc.	Multiple gestation	9	651
Supplementary classification	Live-born infants according to type	Twin birth mates liveborn	9	V31
Supplementary classification	Live-born infants according to type	Other multiples	9	V32-V37
Pregnancy, childbirth, puerperium	Maternal care related to the fetus	Multiple gestation	10	O30
Pregnancy, childbirth, puerperium	Maternal care related to the fetus	Complications to multiple gestation	10	O31
Pregnancy, childbirth, puerperium	Delivery	Multiple delivery	10	O84

Table D3 ICD codes identified in data for pregnancy complications

PREGNANCY COMPLICATIONS			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Abruptio placentae & other placental disorders			
Complications mainly related to pregnancy	Abruptio placentae	9	641.2
Complications mainly related to pregnancy	Other placental conditions affecting management of the mother	9	656.7
Maternal care related fetus, amniotic cavity, possible delivery probs	Abruptio placentae	10	O45
Maternal care related fetus, amniotic cavity, possible delivery probs	Placental disorders	10	O43
Placenta previa			
Complications mainly related to pregnancy	Placenta previa	9	641.0-641.1
Maternal care related fetus, amniotic cavity, possible delivery probs	Placenta previa	10	O44
Premature Rupture of Membranes			
Other indications for care in pregnancy, labor, and delivery	Premature rupture of membranes	9	658.1
Maternal care related fetus, amniotic cavity, possible delivery probs	Premature rupture of membranes	10	O42

INFECTION RELATED HOSPITALISATION			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Infections (any)			
Infectious and parasitic diseases	Any hospitalisation	9	001-139
Infectious and parasitic diseases	Any hospitalisation	10	A00-B99
Respiratory system	Acute respiratory infections	9	460-466
Respiratory system	Acute respiratory infections	10	J00-J06
Respiratory system	Pneumonia and influenza	9	480-488
Respiratory system	Pneumonia and influenza	10	J09-J18
Factors influencing health service contact	Contact with and exposure to communicable diseases	9	V01
Factors influencing health service contact	Contact with and exposure to communicable diseases	10	Z20
Factors influencing health service contact	Carrier of infectious disease	9	V02
Factors influencing health service contact	Carrier of infectious disease	10	Z22
Factors influencing health service contact	Asymptomatic HIV status	9	V08
Factors influencing health service contact	Asymptomatic HIV status	10	Z21
Infections in pregnancy			
Complications related to pregnancy	Infections of the genitourinary tract in pregnancy	9	646.6
Complications related to pregnancy	Infections of the genitourinary tract in pregnancy	10	O23
Complications related to pregnancy	Infective and parasitic conditions in the mother	9	647
Complications related to pregnancy	Infective and parasitic conditions in the mother	10	O98
Complications related to pregnancy	Suspected fetal damage from maternal viral disease	10	O35.3
Certain conditions originating in the perinatal period	Fetus/newborn affected by maternal infectious and parasitic diseases	9	760.2
Certain conditions originating in the perinatal period	Fetus/newborn affected by maternal infectious and parasitic diseases	10	P00.2
Certain conditions originating in the perinatal period	Infections specific to the perinatal period	9	771
Certain conditions originating in the perinatal period	Infections specific to the perinatal period	10	P35-P39
Chronic and sexually transmitted infections			
Tuberculosis	Tuberculosis	9	010-018
Tuberculosis	Tuberculosis	10	A15-A19
HIV	HIV	9	042-044
HIV	HIV	10	B20-B24
Infections with a predominantly sexual mode of transmission	Syphilis and other venereal diseases	9	090-099
Infections with a predominantly sexual mode of transmission	Infections with a predominantly sexual mode of transmission	10	A50-A64
Herpes simplex	Herpes simplex	9	054
Herpes simplex	Herpes simplex	10	B00
Viral hepatitis	Viral hepatitis	9	070
Viral hepatitis	Viral hepatitis	10	B15-B19
Complications related to pregnancy	Infective/parasitic conditions in mother – Syphilis	9	647.0
Complications related to pregnancy	Infective/parasitic conditions in mother – Gonorrhea	9	647.1
Complications related to pregnancy	Infective/parasitic conditions in mother – Other venereal	9	647.2
Complications related to pregnancy	Infective/parasitic conditions in mother – Tuberculosis	9	647.3
Complications related to pregnancy	Infective/parasitic conditions in mother – Tuberculosis	10	O98.0
Complications related to pregnancy	Infective/parasitic conditions in mother – Syphilis	10	O98.1
Complications related to pregnancy	Infective/parasitic conditions in mother – Gonorrhea	10	O98.2
Complications related to pregnancy	Infective/parasitic conditions in mother – Other sexually trans.	10	O98.3
Complications related to pregnancy	Infective/parasitic conditions in mother – Viral hepatitis	10	O98.4
Complications related to pregnancy	Infective/parasitic conditions in mother – HIV	10	O98.7
Factors influencing health service contact	Asymptomatic HIV status	9	V08
Factors influencing health service contact	Asymptomatic HIV status	10	Z21
Factors influencing health service contact	Contact with or exposure to venereal diseases	9	V01.6
Factors influencing health service contact	Contact with or exposure to infections with sexual mode transmission	10	Z20.2
Factors influencing health service contact	Contact with or exposure to viral hepatitis	10	Z20.5
Factors influencing health service contact	Contact with or exposure to HIV	10	Z20.6
Factors influencing health service contact	Carrier of gonorrhoea	9	V02.7
Factors influencing health service contact	Carrier of other venereal diseases	9	V02.8
Factors influencing health service contact	Carrier of infections predominantly sexual mode	10	Z22.4
Factors influencing health service contact	Carrier of viral hepatitis	9	V02.6
Factors influencing health service contact	Carrier of viral hepatitis	10	Z22.5

OTHER FACTORS			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Cancer			
Neoplasms	Malignant neoplasms	9	140-208
Neoplasms	Malignant neoplasms	10	C00-C97
Neoplasms	Neoplasms of uncertain or unspecified nature	9	235-239
Neoplasms	Neoplasms of uncertain or unspecified nature	10	D37-D48
Anaemia			
Diseases of the blood and blood-forming organs	Anaemia	9	280-285
Diseases of the blood and blood-forming organs	Anaemia	10	D50-D64
Complications mainly related to pregnancy	Anaemia complicating pregnancy	9	648.2
Complications mainly related to pregnancy	Anaemia complicating pregnancy	10	O99.0
Nutritional deficiencies			
Endocrine, nutritional and metabolic diseases	Nutritional deficiencies	9	260-269
Endocrine, nutritional and metabolic diseases	Nutritional deficiencies	10	E50-E64
Malnutrition			
Endocrine, nutritional and metabolic diseases	Malnutrition	10	E40-E46
Maternal disorders related to pregnancy	Malnutrition in pregnancy	10	O25
Complications predominantly related to pregnancy	Maternal care for low weight gain in pregnancy	10	O26.1
Obesity			
Endocrine, nutritional and metabolic diseases	Obesity	9	278.0-278.1
Endocrine, nutritional and metabolic diseases	Obesity	10	E65-E66
Complications predominantly related to pregnancy	Maternal care for excessive weight gain in pregnancy	10	O26.0
Diabetes mellitus			
Endocrine, nutritional and metabolic diseases	Diabetes mellitus	9	250
Endocrine, nutritional and metabolic diseases	Diabetes mellitus	10	E10-E14
Complications mainly related to pregnancy	Diabetes mellitus in pregnancy	9	648.0
Complications mainly related to pregnancy	Diabetes mellitus in pregnancy	10	O24
Complications mainly related to pregnancy	Abnormal glucose tolerance complicating pregnancy	9	648.8
Certain conditions originating in the perinatal period	Syndrome of 'infant of a diabetic mother'	9	755.0
Abortion (miscarriage and induced)			
Complications of pregnancy	Ectopic and molar pregnancy	9	630-633
Complications of pregnancy	Other pregnancy with abortive outcome	9	634-639
Complications of pregnancy	Pregnancy with abortive outcome	10	O00-O08
Complications of pregnancy	Pregnancy care of habitual aborter	10	O26.2
Hypertension			
Complications mainly related to pregnancy	Hypertension complicating pregnancy, childbirth and the puerperium	9	642.0 642.2-642.3
Hypertensive disorders in pregnancy	Pre-existing hypertension complicating pregnancy, childbirth, puerperium	10	O10
Hypertensive disorders in pregnancy	Gestational hypertension	10	O13
Hypertensive disorders in pregnancy	Unspecified maternal hypertension	10	O16
Preeclampsia			
Complications mainly related to pregnancy	Preeclampsia	9	642.4-642.5
Complications mainly related to pregnancy	Preeclampsia or eclampsia superimposed on chronic hypertension	9	642.7
Hypertensive disorders in pregnancy	Preeclampsia superimposed on chronic hypertension	10	O11
Hypertensive disorders in pregnancy	Preeclampsia	10	O14
Eclampsia			
Complications mainly related to pregnancy	Eclampsia	9	642.6
Hypertensive disorders in pregnancy	Eclampsia	10	O15
Renal disease			
Genitourinary system	Renal failure	9	584-586
Genitourinary system	Renal failure	10	N17-N19
Factors influencing health service contact	Encounter for dialysis and dialysis catheter care	9	V56
Complications mainly related to pregnancy	Hypertension secondary to renal disease complicating pregnancy	9	642.1
Complications mainly related to pregnancy	Unspecified renal disease in pregnancy without mention of hypertension	9	646.2
Factors influencing health service contact	Care involving dialysis	10	Z49
Maternal care other conditions predominantly related to pregnancy	Pregnancy related renal disease	10	O26.83

Table D4 ICD codes identified in data for exposure to alcohol, drugs and other toxins in pregnancy

EXPOSURE TO ALCOHOL, DRUGS AND OTHER TOXINS IN PREGNANCY			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Endocrine, nutritional and metabolic diseases, etc.			
Diseases of other endocrine glands	Alcoholic pseudo-Cushing syndrome	9	255.0
Mental disorders			
Organic psychotic conditions	Alcoholic psychoses	9	291
Organic psychotic conditions	Drug psychoses	9	292
Psychoactive substance	Alcohol dependence syndrome	9	303
Psychoactive substance	Drug dependence	9	304
Psychoactive substance	Nondependent abuse of drugs	9	305
Diseases of the nervous system			
Degenerative diseases of the central nervous system	Alcoholic nervous system degeneration	9	331.7
Disorders of the peripheral nervous system	Alcoholic polyneuropathy	9	357.5
Disorders of the peripheral nervous system	Toxic myopathy	9	359.4
Diseases of the circulatory system			
Other forms of heart disease	Alcoholic cardiomyopathy	9	425.5
Diseases of the digestive system			
Diseases of esophagus, stomach, and duodenum	Alcoholic gastritis	9	535.3
Other diseases of digestive system	Alcoholic chronic liver disease	9	571.0-571.3
Other diseases of digestive system	Alcoholic pancreatitis	9	577.1
Complications of pregnancy, childbirth, and the puerperium			
Complications mainly related to pregnancy	Drug dependence complicating pregnancy, etc.	9	648.3-648.34
Complications mainly related to pregnancy	Tobacco use disorder complicating pregnancy, etc.	9	649
Normal delivery, other indications for care in pregnancy	Known or suspected fetal abnormality, alcohol	9	655.43
Certain conditions originating in the perinatal period			
Maternal causes of perinatal morbidity and mortality	Noxious influences affecting fetus or newborn	9	760.7
Maternal causes of perinatal morbidity and mortality	Fetal alcohol syndrome	9	760.71
Maternal causes of perinatal morbidity and mortality	Exposure to narcotics, perinatal	9	760.72
Maternal causes of perinatal morbidity and mortality	Other noxious influences affecting fetus/newborn	9	760.79
Ill-defined conditions originating in the perinatal period	Drug reactions/intoxications specific to newborn	9	779.4
Ill-defined conditions originating in the perinatal period	Drug withdrawal syndrome in newborn	9	779.5
Symptoms, signs, and ill-defined conditions			
Nonspecific abnormal findings	Excessive blood level of alcohol	9	790.3
Injury and poisoning			
Poisoning by drugs, medicinal and biological substances	by opium	9	965.0-965.00
Poisoning by drugs, medicinal and biological substances	by heroin	9	965.01
Poisoning by drugs, medicinal and biological substances	by methadone	9	965.02
Poisoning by drugs, medicinal and biological substances	by other opiates and related narcotics	9	965.09
Poisoning by drugs, medicinal and biological substances	by barbiturates	9	967.0
Poisoning by drugs, medicinal and biological substances	by chloral hydrate group	9	967.1
Poisoning by drugs, medicinal and biological substances	by paraldehyde	9	967.2
Poisoning by drugs, medicinal and biological substances	by bromine compounds	9	967.3
Poisoning by drugs, medicinal and biological substances	by methaqualone compounds	9	967.4
Poisoning by drugs, medicinal and biological substances	by glutethimide group	9	967.5
Poisoning by drugs, medicinal and biological substances	by mixed sedatives	9	967.6
Poisoning by drugs, medicinal and biological substances	by other sedatives and hypnotics	9	967.8
Poisoning by drugs, medicinal and biological substances	by unspecified sedative or hypnotic	9	967.9
Poisoning by drugs, medicinal and biological substances	by antidepressants	9	969.0
Poisoning by drugs, medicinal and biological substances	by phenothiazine-based tranquilizers	9	969.1
Poisoning by drugs, medicinal and biological substances	by butyrophenone-based tranquilizers	9	969.2
Poisoning by drugs, medicinal and biological substances	by antipsychotics, neuroleptics, major tranquilizers	9	969.3
Poisoning by drugs, medicinal and biological substances	by benzodiazepine-based tranquilizers	9	969.4
Poisoning by drugs, medicinal and biological substances	by other tranquilizers	9	969.5
Poisoning by drugs, medicinal and biological substances	by psychodysleptics (hallucinogens)	9	969.6
Poisoning by drugs, medicinal and biological substances	by psychostimulants	9	969.7
Poisoning by drugs, medicinal and biological substances	by other specified psychotropic agents	9	969.8
Poisoning by drugs, medicinal and biological substances	by unspecified psychotropic agents	9	969.9
Poisoning by drugs, medicinal and biological substances	by opiate antagonists	9	970.1
Poisoning by drugs, medicinal and biological substances	by other specified CNS stimulants (inc. cocaine)	9	970.8
Poisoning by drugs, medicinal and biological substances	by unspecified CNS stimulants	9	970.9
Poisoning by drugs, medicinal and biological substances	by alcohol deterrents	9	977.3
Toxic effects of substances chiefly nonmedicinal	Toxic effect of alcohol	9	980
Toxic effects of substances chiefly nonmedicinal	Toxic effect of petroleum products	9	981
Toxic effects of substances chiefly nonmedicinal	Toxic effect of other solvents	9	982
Toxic effects of substances chiefly nonmedicinal	Toxic effect of lead (including fumes)	9	984
Toxic effects of substances chiefly nonmedicinal	Toxic effect of other gases, fumes, or vapors	9	987

External causes of injury			
Accidental poisoning by drugs, medicinal substances, etc.	by heroin	9	E850.0
Accidental poisoning by drugs, medicinal substances, etc.	by methadone	9	E850.1
Accidental poisoning by drugs, medicinal substances, etc.	by other opiates and related narcotics	9	E850.2
Accidental poisoning by drugs, medicinal substances, etc.	by barbiturates	9	E851
Accidental poisoning by drugs, medicinal substances, etc.	by sedatives and hypnotics	9	E852
Accidental poisoning by drugs, medicinal substances, etc.	by tranquilizers	9	E853
Accidental poisoning by drugs, medicinal substances, etc.	by other psychotropic agents	9	E854
Accidental poisoning by other solid and liquid substances	by alcohol not elsewhere	9	E860
Accidental poisoning by other solid and liquid substances	by petroleum, other solvents	9	E862
Accidental poisoning by other solid and liquid substances	by other gases and vapors	9	E869
Suicide and self-inflicted injury	Suicide and self-inflicted poisoning solid, liquid	9	E950
Suicide and self-inflicted injury	Suicide and self-inflicted poisoning by dgases	9	E951
Suicide and self-inflicted injury	Suicide and self-inflicted poisoning by other gases	9	E952
Undetermined Whether Accidentally Or Purposely Inflicted	by analgesics, antipyretics, and antirheumatics	9	E980.0
Undetermined Whether Accidentally Or Purposely Inflicted	by barbiturates	9	E980.1
Undetermined Whether Accidentally Or Purposely Inflicted	other sedatives and hypnotics	9	E980.2
Undetermined Whether Accidentally Or Purposely Inflicted	by tranquilizers and other psychotropic agents	9	E980.3
Undetermined Whether Accidentally Or Purposely Inflicted	by other specified drugs and medicinal substances	9	E980.4
Undetermined Whether Accidentally Or Purposely Inflicted	by unspecified drug or medicinal substance	9	E980.5
Undetermined Whether Accidentally Or Purposely Inflicted	by other and unspecified solid, liquid substances	9	E980.9
Undetermined Whether Accidentally Or Purposely Inflicted	Poisoning by gases in domestic use	9	E981
Undetermined Whether Accidentally Or Purposely Inflicted	Poisoning by other gases	9	E982
Supplementary classification of factors			
Persons with potential health hazards	Personal history of alcoholism	9	V11.3
Persons encountering health services, other circumstances	Counseling on substance use and abuse	9	V65.42
Special screening for mental disorders	Screening for alcoholism	9	V79.1
Endocrine, nutritional and metabolic diseases			
Disorders of other endocrine glands	Drug-induced Cushing syndrome	10	E24.2
Disorders of other endocrine glands	Alcohol-induced pseudo-Cushing syndrome	10	E24.4
Mental and behavioural disorders			
Due to psychoactive substance use	due to use of alcohol	10	F10
Due to psychoactive substance use	due to use of opioids	10	F11
Due to psychoactive substance use	due to use of cannabinoids	10	F12
Due to psychoactive substance use	due to use of sedatives or hypnotics	10	F13
Due to psychoactive substance use	due to use of cocaine	10	F14
Due to psychoactive substance use	due to use of other stimulants, including caffeine	10	F15
Due to psychoactive substance use	due to use of hallucinogens	10	F16
Due to psychoactive substance use	due to use of tobacco	10	F17
Due to psychoactive substance use	due to use of volatile solvents	10	F18
Due to psychoactive substance use	due to multiple drug use, or other substances	10	F19
Diseases of the nervous system			
Other degenerative diseases of the nervous system	Degeneration of nervous system due to alcohol	10	G31.2
Polyneuropathies, disorders of peripheral nervous system	Drug-induced polyneuropathy	10	G62.0
Polyneuropathies, disorders of peripheral nervous system	Alcoholic polyneuropathy	10	G62.1
Diseases of myoneural junction and muscle	Drug-induced myopathy	10	G72.0
Diseases of myoneural junction and muscle	Alcoholic myopathy	10	G72.1
Diseases of the circulatory system			
Other forms of heart disease	Alcoholic cardiomyopathy	10	I42.6
Other forms of heart disease	Cardiomyopathy due to drugs and external agents	10	I42.7
Diseases of the digestive system			
Diseases of oesophagus, stomach and duodenum	Alcoholic gastritis	10	K29.2
Diseases of liver	Alcoholic liver disease	10	K70
Disorders of gallbladder, biliary tract and pancreas	Alcohol-induced chronic pancreatitis	10	K86.0
Pregnancy, childbirth and the puerperium			
Maternal care for known/suspected fetal abnorm/damage	Maternal care for damage to fetus from alcohol	10	O35.4
Maternal care for known/suspected fetal abnorm/damage	Maternal care for damage to fetus by drugs	10	O35.5
Certain conditions originating in the perinatal period			
Fetus/newborn affected noxious via placenta/breast milk	Fetus/newborn affected by maternal use tobacco	10	P04.2
Fetus/newborn affected noxious via placenta/breast milk	Fetus/newborn affected by maternal use alcohol	10	P04.3
Fetus/newborn affected noxious via placenta/breast milk	Fetus/newborn affected by maternal use drugs	10	P04.4
Congenital malformations, deformations, etc.			
Other congenital malformations	Fetal alcohol syndrome (dysmorphic)	10	Q86.0
Symptoms, signs, etc. not elsewhere classified			
Findings of drugs and substances, not normally in blood	Finding of alcohol in blood	10	R78.0
Findings of drugs and substances, not normally in blood	Finding of opiate in blood	10	R78.1
Findings of drugs and substances, not normally in blood	Finding of cocaine in blood	10	R78.2
Findings of drugs and substances, not normally in blood	Finding of hallucinogen in blood	10	R78.3
Findings of drugs and substances, not normally in blood	Finding of other drug addictive potential in blood	10	R78.4
Findings of drugs and substances, not normally in blood	Finding of psychotropic drug in blood	10	R78.5

Injury, poisoning, other consequences of external causes			
Poisoning by drugs, medicaments, biological substances	by narcotics and psychodysleptics	10	T40
Poisoning by drugs, medicaments, biological substances	by barbiturates	10	T42.3
Poisoning by drugs, medicaments, biological substances	by benzodiazepines	10	T42.4
Poisoning by drugs, medicaments, biological substances	by other antiepileptic and sedative-hypnotic drugs	10	T42.6
Poisoning by drugs, medicaments, biological substances	by unspecified sedative-hypnotic drugs	10	T42.7
Poisoning by drugs, medicaments, biological substances	Poisoning by psychotropic drugs, other	10	T43
Poisoning by drugs, medicaments, biological substances	by alcohol deterrent	10	T50.6
Poisoning by drugs, medicaments, biological substances	by opiate antagonist	10	T50.7
Poisoning by drugs, medicaments, biological substances	Toxic effect of alcohol	10	T51
Poisoning by drugs, medicaments, biological substances	Toxic effect of organic solvents	10	T52
Poisoning by drugs, medicaments, biological substances	Toxic effect of aromatic hydrocarbons, etc. [CFCs]	10	T53
Poisoning by drugs, medicaments, biological substances	Toxic effect of other gases, fumes and vapours	10	T59
External causes of morbidity and mortality			
Accidental poisoning by noxious substances	by antiepileptic, sedative-hypnotic,psychotropic etc	10	X41
Accidental poisoning by noxious substances	by and exposure to narcotics and psychodysleptics	10	X42
Accidental poisoning by noxious substances	by alcohol	10	X45
Accidental poisoning by noxious substances	by organic solvents,hydrocarbons and their vapours	10	X46
Accidental poisoning by noxious substances	by other gases and vapours	10	X47
Intentional self-harm	by antiepileptic, sedative-hypnotic,psychotropic etc	10	X61
Intentional self-harm	by and exposure to narcotics and psychodysleptics	10	X62
Intentional self-harm	by alcohol	10	X65
Intentional self-harm	by organic solvents,hydrocarbons and their vapours	10	X66
Intentional self-harm	by other gases and vapours	10	X67
Event of undetermined intent	by antiepileptic, sedative-hypnotic,psychotropic etc	10	Y11
Event of undetermined intent	by and exposure to narcotics and psychodysleptics	10	Y12
Event of undetermined intent	by alcohol	10	Y15
Event of undetermined intent	by organic solvents,hydrocarbons and their vapours	10	Y16
Event of undetermined intent	by other gases and vapours	10	Y17
Supplementary factors related to causes of morbidity	Evidence of alcohol involvement, BAC	10	Y90
Supplementary factors related to causes of morbidity	Evidence of alcohol involvement, level intoxication	10	Y91
Factors influencing health status, health service contact			
Persons encountering health services, specific care	Alcohol rehabilitation	10	Z50.2
Persons encountering health services, specific care	Drug rehabilitation	10	Z50.3
Persons encountering health services, other circumstances	Alcohol abuse counselling and surveillance	10	Z71.4
Persons encountering health services, other circumstances	Drug abuse counselling and surveillance	10	Z71.5
Problems related to lifestyle	Alcohol use	10	Z72.1
Problems related to lifestyle	Drug use	10	Z72.2
Persons with potential health hazards	Personal history of psychoactive substance abuse	10	Z86.4

Table D5 ICD codes identifed in data for injury by external causes in pregnancy

INJURY BY EXTERNAL CAUSES			
Chapter / Diagnosis level 1	**Diagnosis level 2**	**ICD ed.**	**ICD codes**
External causes (excl. poisoning & medical comp.)			
Accidents	Transport accidents	9	E800-E848
	Accidents in the home (all entries under 'place of occurrence' = home)		E849.0
	Accidents (falls, fire, natural factors, drowning, other)		E880-E929
Accidents	Transport accidents	10	V01-V99 Y85
	Accidents (falls, mechanical forces, fire, natural factors, drowning, other)		W00-X39 X50-X59 Y86
Undetermined intent	Injury undetermined if accidental or purposely inflicted (excl. poisoning)	9	E983-E989
Undetermined intent	Injury undetermined if accidental or purposely inflicted (excl. poisoning)	10	Y20-Y34 Y87.2
Legal intervention	Injury due to legal intervention (e.g. manhandling)	9	E970-E977
Legal intervention	Injury due to legal intervention (e.g. manhandling)	10	Y35 Y89
Assault (excl. poisoning)			
Assault	Injury purposely inflicted by other persons (excl. by poisoning)	9	E960-E961 E963-E969
Assault	Assault (excl. by poisoning)	10	X91-Y09 Y87.1

Table D6 ICD codes identifed in data for service contact for materanl mental illness in pregnancy

MATERNAL MENTAL ILLNESS			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD	ICD codes
Mental Health Service Presentation			
Mental Health Service Presentation	Any MHIS contact (excl. substance-use related)	9-10	Any
	****exclude codes for alcohol or substances with abuse potential****		**exc. Drug/Alc**
Hospitalisation			
Mental and behavioural disorders	Any hospitalisation (excl. substance-use related)	9	290-319
	****exclude codes for alcohol or substances with abuse potential****		**exc. Drug/Alc**
Mental and behavioural disorders	Any hospitalisation (excl. substance-use related)	10	F00-F99
	****exclude codes for alcohol or substances with abuse potential****		**exc. Drug/Alc**
Factors influencing health service contact	Personal history of a mental disorder	9	V11
Factors influencing health service contact	Mental and behavioural problems	9	V40
Factors influencing health service contact	Screening for mental disorders	9	V79
Factors influencing health service contact	General psychiatric examination	10	Z00.4 Z04.6
Factors influencing health service contact	Observation for suspected mental disorder	10	Z03.2
Complications mainly relating to pregnancy	Mental disorders complicating pregnancy, etc.	9	648.4
Complications mainly relating to pregnancy	Mental disorders complicating pregnancy, etc.	10	O99.3
Self-harm (excl. poisoning)			
Self-inflicted injury	Suicide and self-inflicted injury (excl. by poisoning)	9	E953-E959
Self-inflicted injury	Suicide and self-inflicted injury (excl. by poisoning)	10	X70-X84 Y87.0

Appendix E Supplementary tables – Study I

Table E1 Characteristics of children born in Western Australia (1985-2011) affected by maternal incarceration during childhood (0-17 years) and their mothers

Characteristics	Aboriginal n (%)	Non-Aboriginal n (%)	Total n (%)
Children characteristics			
Number of children	5943 (64)	3409 (36)	9352 (100)
Sex			
Male	3021 (51)	1772 (52)	4793 (52)
Female	2922 (49)	1637 (48)	4559 (48)
Age at first exposure***			
Birth	109 (2)	83 (2)	192 (2)
0-4 years	3235 (54)	1606 (47)	4841 (52)
5-9 years	1530 (26)	979 (29)	2509 (27)
10-14 years	809 (14)	560 (16)	1369 (15)
15-17 years	260 (4)	181 (5)	441 (5)
Socio-economic level[a]***			
1 (least disadvantaged)	70 (1)	191 (6)	261 (2)
2	215 (4)	368 (11)	583 (6)
3	566 (10)	572 (17)	1138 (12)
4	1196 (20)	880 (26)	2076 (22)
5 (most disadvantaged)	3884 (65)	1384 (41)	5268 (56)
Mother characteristics			
Number of mothers	2075 (54)	1752 (46)	3827 (100)
Number of children[a]	5785 (62)	3567 (38)	9352 (100)
Children per mother***			
1	655 (32)	759 (43)	1414 (37)
2	438 (21)	501 (29)	939 (25)
3	375 (18)	293 (17)	668 (17)
4	261 (13)	117 (7)	378 (10)
5+	346 (17)	82 (5)	428 (11)
Age at imprisonment[b]***			
13-17 years	107 (5)	25 (1)	132 (3)
18-19 years	233 (11)	76 (4)	309 (8)
20-24 years	669 (32)	430 (24)	1099 (28)
25-29 years	489 (23)	448 (25)	937 (24)
30-34 years	328 (16)	375 (21	703 (18)
35-39 years	172 (8)	228 (13)	400 (10)
40+ years	69(3)	117 (7)	186 (5)
Imprisonment characteristics			
Number prison records	8130 (66)	4240 (34)	12370 (100)
Records per mother***			
1	755 (36)	877 (50)	1632 (43)
2	374 (18)	359 (20)	733 (19)
3	249 (12)	191 (11)	440 (12)
4	155 (7)	118 (7)	273 (7)
5+	542 (26)	207 (12)	749 (20)
Duration***			
< 24 hours	716 (9)	454 (11)	1170 (9)
1-7 days	2305 (28)	1085 (26)	3390 (27)
1-4 weeks	1838 (23)	803 (19)	2641 (21)
1-3 months	1373 (17)	645 (15)	2018 (16)
3-6 months	838 (10)	510 (12)	1348 (11)
6-12 months	657 (8)	402 (9)	1059 (9)
1-2 years	320 (4)	257 (6)	577 (5)
2+ years	83 (1)	84 (2)	167 (1)

Imprisonments cont.			
Sentence type[c]***			
Unsentenced	3254 (40)	1972 (47)	5226 (42)
Sentenced	4876 (60)	2268 (53)	7144 (58)
Offence type[d]***			
Homicide	68 (1)	31 (1)	99 (1)
Injury	1830 (24)	419 (10)	2249 (20)
Sexual assault	12 (<1)	21 (<1)	33 (<1)
Endangerment	423 (5)	76 (2)	499 (4)
Abduction	91 (1)	42 (1)	133 (1)
Robbery/extortion	305 (4)	212 (5)	517 (4)
Unlawful entry	921 (12)	512 (13)	1433 (12)
Theft	867 (11)	524 (13)	1391 (12)
Fraud	182 (2)	518 (13)	700 (6)
Illicit drug	87 (1)	452 (11)	539 (5)
Weapons	20 (<1)	11 (<1)	31 (<1)
Property damage	196 (3)	57 (1)	253 (2)
Public order	312 (4)	55 (1)	367 (3)
Traffic regulatory	852 (11)	461 (11)	1313 (11)
Justice procedures	1476 (19)	656 (16)	2132 (18)
Miscellaneous	57 (1)	36 (1)	93 (1)

Notes: [a]Missing socioeconomic data for 12 Aboriginal and 14 non-Aboriginal children. [b]Age of mother determined at imprisonment when first child entered the cohort during the study period. [c]'Sentenced' imprisonments can include a period where the prisoner is held on remand (unsentenced) before they were sentenced. [d]Offence data missing for 431 Aboriginal and 157 non-Aboriginal records of imprisonment. *** $p<0.001$

Table E2 Annual prevalence of maternal incarceration in Western Australia

Aged 0-4 years								
	Western Australia		Indigenous		Non-Indigenous			
Year	n	%	n	%	n	%	PR*	95% CI
1990	289	0.228	210	2.934	79	0.066	44.3	34.3-57.3
1991	238	0.187	172	2.289	66	0.055	41.5	31.3-55.0
1992	264	0.208	192	2.466	72	0.060	40.8	31.2-53.5
1993	346	0.273	262	3.250	84	0.071	45.9	35.9-58.6
1994	309	0.244	248	2.967	61	0.052	57.5	43.5-76.0
1995	178	0.141	119	1.340	59	0.050	28.0	20.5-38.2
1996	180	0.142	131	1.360	49	0.042	32.5	23.5-45.2
1997	266	0.208	200	2.038	66	0.056	36.4	27.6-48.0
1998	337	0.264	250	2.526	87	0.074	34.2	26.8-43.6
1999	391	0.306	279	2.805	112	0.095	29.5	23.7-36.7
2000	425	0.333	260	2.566	165	0.141	18.3	15.0-22.2
2001	435	0.342	248	2.418	187	0.160	15.1	12.5-18.3
2002	378	0.299	243	2.340	135	0.117	20.1	16.3-24.8
2003	413	0.328	270	2.581	143	0.124	20.8	17.0-25.5
2004	469	0.374	310	2.979	159	0.138	21.6	17.8-26.1
2005	456	0.360	320	3.102	136	0.117	26.5	21.7-32.4
2006	368	0.284	254	2.428	114	0.096	25.4	20.4-31.7
2007	457	0.336	313	2.966	144	0.115	25.8	21.2-31.4
2008	459	0.321	316	2.966	143	0.108	27.4	22.5-33.4
2009	462	0.310	315	2.933	147	0.106	27.6	22.7-33.6
2010	546	0.356	350	3.252	196	0.137	23.7	19.9-28.2
2011	337	0.215	231	2.214	106	0.073	30.5	24.2-38.3
Average annual percentage change		2.2		1.4		3.4		

*Prevalence Ratio

Aged 0-9 years								
	Western Australia		Indigenous		Non-Indigenous			
Year	n	%	n	%	n	%	PR*	95% CI
1995	310	0.120	214	1.369	96	0.039	34.7	27.3-44.1
1996	318	0.122	237	1.293	81	0.034	38.6	30.0-49.6
1997	480	0.184	358	1.929	122	0.050	38.2	31.1-46.9
1998	612	0.234	471	2.505	141	0.058	43.2	35.8-52.1
1999	774	0.295	586	3.056	188	0.077	39.6	33.6-46.6
2000	833	0.317	548	2.810	285	0.117	24.0	20.8-27.7
2001	882	0.336	550	2.774	332	0.137	20.3	17.7-23.2
2002	755	0.289	501	2.487	254	0.105	23.6	20.3-27.4
2003	858	0.330	575	2.830	283	0.118	24.0	20.8-27.6
2004	988	0.380	657	3.231	331	0.138	23.4	20.5-26.7
2005	918	0.352	642	3.144	276	0.115	27.4	23.8-31.5
2006	753	0.284	508	2.459	245	0.100	24.5	21.1-28.6
2007	959	0.352	640	3.067	319	0.127	24.2	21.2-27.7
2008	980	0.348	665	3.163	315	0.121	26.2	22.9-29.9
2009	968	0.334	633	3.007	335	0.125	24.2	21.2-27.6
2010	1152	0.388	712	3.392	440	0.160	21.2	18.9-23.9
2011	762	0.251	500	2.403	262	0.092	26.0	22.4-30.1
Average annual percentage change		6.7		5.4		8.7		

*Prevalence Ratio

Aged 0-17 years								
	Western Australia		Indigenous		Non-Indigenous			
Year	n	%	n	%	n	%	PR*	95% CI
2003	1411	0.290	981	2.907	430	0.095	30.6	27.3-34.3
2004	1591	0.327	1095	3.205	496	0.110	29.2	26.3-32.5
2005	1515	0.310	1070	3.101	445	0.098	31.7	28.4-35.4
2006	1254	0.253	849	2.421	405	0.088	27.5	24.5-31.0
2007	1606	0.318	1088	3.063	518	0.110	27.8	25.0-30.8
2008	1615	0.313	1087	3.029	528	0.110	27.5	24.8-30.5
2009	1602	0.304	1036	2.864	566	0.115	24.8	22.4-27.5
2010	2005	0.375	1251	3.440	754	0.151	22.8	20.8-24.9
2011	1301	0.239	851	2.338	450	0.089	26.4	23.6-29.6
Average annual percentage change		-0.3		-0.9		1.8		

*Prevalence Ratio

Table E3 Childhood prevalence of maternal incarceration in Western Australia

Aged 0-4 years								
	Western Australia		Indigenous		Non-Indigenous			
Birth Year	n	%	n	%	n	%	PR*	95% CI
1985	154	0.666	112	n.a.	42	n.a.	-	-
1986	184	0.759	130	n.a.	54	n.a.	-	-
1987	153	0.656	115	n.a.	38	n.a.	-	-
1988	168	0.668	123	n.a.	45	n.a.	-	-
1989	177	0.707	114	n.a.	63	n.a.	-	-
1990	179	0.706	117	n.a.	62	n.a.	-	-
1991	167	0.657	115	n.a.	52	n.a.	-	-
1992	164	0.654	123	10.123	41	0.172	58.9	41.6-83.5
1993	164	0.654	124	8.078	40	0.170	47.6	33.4-67.7
1994	156	0.621	114	7.224	42	0.178	40.5	28.6-57.5
1995	163	0.648	111	7.440	52	0.220	33.8	24.4-46.8
1996	181	0.730	114	7.412	67	0.288	25.7	19.1-34.6
1997	228	0.920	146	9.905	82	0.352	28.1	21.6-36.7
1998	212	0.858	133	9.060	79	0.340	26.7	20.3-35.0
1999	226	0.909	131	8.408	95	0.408	20.6	15.9-26.7
2000	232	0.925	146	8.483	86	0.368	23.1	17.7-30.0
2001	224	0.933	135	8.453	89	0.397	21.3	16.4-27.7
2002	237	1.004	147	9.926	90	0.407	24.4	18.9-31.5
2003	230	0.948	151	8.951	79	0.350	25.6	19.6-33.4
2004	196	0.775	124	7.213	72	0.305	23.6	17.7-31.4
2005	236	0.899	158	8.962	78	0.318	28.1	21.5-36.7
2006	249	0.896	145	7.588	104	0.402	18.9	14.7-24.2
2007	226	0.775	144	6.789	82	0.303	22.4	17.1-29.3
2008	179	0.562	127	5.135	52	0.177	29.0	21.1-40.0
2009	157	0.508	107	4.429	50	0.176	25.2	18.1-35.2
Average annual percentage change		-0.4		-3.6		2.0		

*Prevalence Ratio

Aged 0-9 years								
	Western Australia		Indigenous		Non-Indigenous			
Birth Year	n	%	n	%	n	%	PR*	95% CI
1985	237	1.026	161	n.a.	76	n.a.	-	-
1986	255	1.052	178	n.a.	77	n.a.	-	-
1987	222	0.951	160	n.a.	62	n.a.	-	-
1988	227	0.903	154	n.a.	73	n.a.	-	-
1989	253	1.010	165	n.a.	88	n.a.	-	-
1990	262	1.033	174	n.a.	88	n.a.	-	-
1991	284	1.117	198	n.a.	86	n.a.	-	-
1992	302	1.204	217	17.860	85	0.356	50.1	39.3-64.0
1993	320	1.276	219	14.267	101	0.429	33.3	26.4-41.9
1994	317	1.261	206	13.055	111	0.471	27.7	22.1-34.7
1995	321	1.277	203	13.606	118	0.499	27.3	21.9-34.0
1996	327	1.319	212	13.784	115	0.495	27.8	22.3-34.7
1997	343	1.384	212	14.383	131	0.562	25.6	20.7-31.6
1998	354	1.432	223	15.191	131	0.563	27.0	21.9-33.2
1999	363	1.461	215	13.800	148	0.635	21.7	17.7-26.6
2000	380	1.514	232	13.481	148	0.633	21.3	17.4-26.0
2001	363	1.512	202	12.649	161	0.719	17.6	14.4-21.5
2002	380	1.610	231	15.598	149	0.674	23.2	19.0-28.3
2003	336	1.384	214	12.685	122	0.540	23.5	18.9-29.2
2004	318	1.257	191	11.111	127	0.539	20.6	16.6-25.7
Average annual percentage change		1.3		-3.2		4.1		

*Prevalence Ratio

Aged 0-17 years								
	Western Australia		Indigenous		Non-Indigenous			
Birth Year	n	%	n	%	n	%	PR*	95% CI
1985	313	1.355	214	n.a.	99	n.a.	-	-
1986	348	1.436	232	n.a.	116	n.a.	-	-
1987	341	1.462	244	n.a.	97	n.a.	-	-
1988	361	1.436	253	n.a.	108	n.a.	-	-
1989	385	1.537	248	n.a.	137	n.a.	-	-
1990	412	1.625	261	n.a.	151	n.a.	-	-
1991	429	1.688	284	n.a.	145	n.a.	-	-
1992	447	1.783	288	23.704	159	0.666	35.6	29.6-42.8
1993	468	1.866	304	19.805	164	0.697	28.4	23.7-34.1
1994	435	1.730	266	16.857	169	0.717	23.5	19.5-28.3
1995	457	1.818	264	17.694	193	0.816	21.7	18.1-25.9
1996	422	1.702	264	17.165	158	0.679	25.3	20.9-30.6
Average annual percentage change		2.2		-7.3		1.1		

*Prevalence Ratio

Appendix F Supplementary tables – Study III

Table F1 List of ICD codes used to define the study variables

EXPOSURE TO ALCOHOL, DRUGS AND OTHER TOXINS IN PREGNANCY			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Endocrine, nutritional and metabolic diseases, etc.			
Diseases of other endocrine glands	Alcoholic pseudo-Cushing syndrome	9	255.0
Mental disorders			
Organic psychotic conditions	Alcoholic psychoses	9	291
Organic psychotic conditions	Drug psychoses	9	292
Psychoactive substance	Alcohol dependence syndrome	9	303
Psychoactive substance	Drug dependence	9	304
Psychoactive substance	Nondependent abuse of drugs	9	305
Diseases of the nervous system			
Degenerative diseases of the central nervous system	Alcoholic nervous system degeneration	9	331.7
Disorders of the peripheral nervous system	Alcoholic polyneuropathy	9	357.5
Disorders of the peripheral nervous system	Toxic myopathy	9	359.4
Diseases of the circulatory system			
Other forms of heart disease	Alcoholic cardiomyopathy	9	425.5
Diseases of the digestive system			
Diseases of esophagus, stomach, and duodenum	Alcoholic gastritis	9	535.3
Other diseases of digestive system	Alcoholic chronic liver disease	9	571.0-571.3
Other diseases of digestive system	Alcoholic pancreatitis	9	577.1
Complications of pregnancy, childbirth, and the puerperium			
Complications mainly related to pregnancy	Drug dependence complicating pregnancy, etc.	9	648.3-648.34
Complications mainly related to pregnancy	Tobacco use disorder complicating pregnancy, etc.	9	649
Normal delivery, other indications for care in pregnancy	Known or suspected fetal abnormality, alcohol	9	655.43
Certain conditions originating in the perinatal period			
Maternal causes of perinatal morbidity and mortality	Noxious influences affecting fetus or newborn	9	760.7
Maternal causes of perinatal morbidity and mortality	Fetal alcohol syndrome	9	760.71
Maternal causes of perinatal morbidity and mortality	Exposure to narcotics, perinatal	9	760.72
Maternal causes of perinatal morbidity and mortality	Other noxious influences affecting fetus/newborn	9	760.79
Ill-defined conditions originating in the perinatal period	Drug reactions/intoxications specific to newborn	9	779.4
Ill-defined conditions originating in the perinatal period	Drug withdrawal syndrome in newborn	9	779.5
Symptoms, signs, and ill-defined conditions			
Nonspecific abnormal findings	Excessive blood level of alcohol	9	790.3
Injury and poisoning			
Poisoning by drugs, medicinal and biological substances	by opium	9	965.0-965.00
Poisoning by drugs, medicinal and biological substances	by heroin	9	965.01
Poisoning by drugs, medicinal and biological substances	by methadone	9	965.02
Poisoning by drugs, medicinal and biological substances	by other opiates and related narcotics	9	965.09
Poisoning by drugs, medicinal and biological substances	by barbiturates	9	967.0
Poisoning by drugs, medicinal and biological substances	by chloral hydrate group	9	967.1
Poisoning by drugs, medicinal and biological substances	by paraldehyde	9	967.2
Poisoning by drugs, medicinal and biological substances	by bromine compounds	9	967.3
Poisoning by drugs, medicinal and biological substances	by methaqualone compounds	9	967.4
Poisoning by drugs, medicinal and biological substances	by glutethimide group	9	967.5
Poisoning by drugs, medicinal and biological substances	by mixed sedatives	9	967.6
Poisoning by drugs, medicinal and biological substances	by other sedatives and hypnotics	9	967.8
Poisoning by drugs, medicinal and biological substances	by unspecified sedative or hypnotic	9	967.9
Poisoning by drugs, medicinal and biological substances	by antidepressants	9	969.0
Poisoning by drugs, medicinal and biological substances	by phenothiazine-based tranquilizers	9	969.1
Poisoning by drugs, medicinal and biological substances	by butyrophenone-based tranquilizers	9	969.2
Poisoning by drugs, medicinal and biological substances	by antipsychotics, neuroleptics, major tranquilizers	9	969.3
Poisoning by drugs, medicinal and biological substances	by benzodiazepine-based tranquilizers	9	969.4
Poisoning by drugs, medicinal and biological substances	by other tranquilizers	9	969.5
Poisoning by drugs, medicinal and biological substances	by psychodysleptics (hallucinogens)	9	969.6
Poisoning by drugs, medicinal and biological substances	by psychostimulants	9	969.7
Poisoning by drugs, medicinal and biological substances	by other specified psychotropic agents	9	969.8
Poisoning by drugs, medicinal and biological substances	by unspecified psychotropic agents	9	969.9
Poisoning by drugs, medicinal and biological substances	by opiate antagonists	9	970.1
Poisoning by drugs, medicinal and biological substances	by other specified CNS stimulants (inc. cocaine)	9	970.8
Poisoning by drugs, medicinal and biological substances	by unspecified CNS stimulants	9	970.9
Poisoning by drugs, medicinal and biological substances	by alcohol deterrents	9	977.3
Toxic effects of substances chiefly nonmedicinal	Toxic effect of alcohol	9	980
Toxic effects of substances chiefly nonmedicinal	Toxic effect of petroleum products	9	981
Toxic effects of substances chiefly nonmedicinal	Toxic effect of other solvents	9	982
Toxic effects of substances chiefly nonmedicinal	Toxic effect of lead (including fumes)	9	984
Toxic effects of substances chiefly nonmedicinal	Toxic effect of other gases, fumes, or vapors	9	987

External causes of injury			
Accidental poisoning by drugs, medicinal substances, etc.	by heroin	9	E850.0
Accidental poisoning by drugs, medicinal substances, etc.	by methadone	9	E850.1
Accidental poisoning by drugs, medicinal substances, etc.	by other opiates and related narcotics	9	E850.2
Accidental poisoning by drugs, medicinal substances, etc.	by barbiturates	9	E851
Accidental poisoning by drugs, medicinal substances, etc.	by sedatives and hypnotics	9	E852
Accidental poisoning by drugs, medicinal substances, etc.	by tranquilizers	9	E853
Accidental poisoning by drugs, medicinal substances, etc.	by other psychotropic agents	9	E854
Accidental poisoning by other solid and liquid substances	by alcohol not elsewhere	9	E860
Accidental poisoning by other solid and liquid substances	by petroleum, other solvents	9	E862
Accidental poisoning by other solid and liquid substances	by other gases and vapors	9	E869
Suicide and self-inflicted injury	Suicide and self-inflicted poisoning solid, liquid	9	E950
Suicide and self-inflicted injury	Suicide and self-inflicted poisoning by dgases	9	E951
Suicide and self-inflicted injury	Suicide and self-inflicted poisoning by other gases	9	E952
Undetermined Whether Accidentally Or Purposely Inflicted	by analgesics, antipyretics, and antirheumatics	9	E980.0
Undetermined Whether Accidentally Or Purposely Inflicted	by barbiturates	9	E980.1
Undetermined Whether Accidentally Or Purposely Inflicted	other sedatives and hypnotics	9	E980.2
Undetermined Whether Accidentally Or Purposely Inflicted	by tranquilizers and other psychotropic agents	9	E980.3
Undetermined Whether Accidentally Or Purposely Inflicted	by other specified drugs and medicinal substances	9	E980.4
Undetermined Whether Accidentally Or Purposely Inflicted	by unspecified drug or medicinal substance	9	E980.5
Undetermined Whether Accidentally Or Purposely Inflicted	by other and unspecified solid, liquid substances	9	E980.9
Undetermined Whether Accidentally Or Purposely Inflicted	Poisoning by gases in domestic use	9	E981
Undetermined Whether Accidentally Or Purposely Inflicted	Poisoning by other gases	9	E982
Supplementary classification of factors			
Persons with potential health hazards	Personal history of alcoholism	9	V11.3
Persons encountering health services, other circumstances	Counseling on substance use and abuse	9	V65.42
Special screening for mental disorders	Screening for alcoholism	9	V79.1
Endocrine, nutritional and metabolic diseases			
Disorders of other endocrine glands	Drug-induced Cushing syndrome	10	E24.2
Disorders of other endocrine glands	Alcohol-induced pseudo-Cushing syndrome	10	E24.4
Mental and behavioural disorders			
Due to psychoactive substance use	due to use of alcohol	10	F10
Due to psychoactive substance use	due to use of opioids	10	F11
Due to psychoactive substance use	due to use of cannabinoids	10	F12
Due to psychoactive substance use	due to use of sedatives or hypnotics	10	F13
Due to psychoactive substance use	due to use of cocaine	10	F14
Due to psychoactive substance use	due to use of other stimulants, including caffeine	10	F15
Due to psychoactive substance use	due to use of hallucinogens	10	F16
Due to psychoactive substance use	due to use of tobacco	10	F17
Due to psychoactive substance use	due to use of volatile solvents	10	F18
Due to psychoactive substance use	due to multiple drug use, or other substances	10	F19
Diseases of the nervous system			
Other degenerative diseases of the nervous system	Degeneration of nervous system due to alcohol	10	G31.2
Polyneuropathies, disorders of peripheral nervous system	Drug-induced polyneuropathy	10	G62.0
Polyneuropathies, disorders of peripheral nervous system	Alcoholic polyneuropathy	10	G62.1
Diseases of myoneural junction and muscle	Drug-induced myopathy	10	G72.0
Diseases of myoneural junction and muscle	Alcoholic myopathy	10	G72.1
Diseases of the circulatory system			
Other forms of heart disease	Alcoholic cardiomyopathy	10	I42.6
Other forms of heart disease	Cardiomyopathy due to drugs and external agents	10	I42.7
Diseases of the digestive system			
Diseases of oesophagus, stomach and duodenum	Alcoholic gastritis	10	K29.2
Diseases of liver	Alcoholic liver disease	10	K70
Disorders of gallbladder, biliary tract and pancreas	Alcohol-induced chronic pancreatitis	10	K86.0
Pregnancy, childbirth and the puerperium			
Maternal care for known/suspected fetal abnorm/damage	Maternal care for damage to fetus from alcohol	10	O35.4
Maternal care for known/suspected fetal abnorm/damage	Maternal care for damage to fetus by drugs	10	O35.5
Certain conditions originating in the perinatal period			
Fetus/newborn affected noxious via placenta/breast milk	Fetus/newborn affected by maternal use tobacco	10	P04.2
Fetus/newborn affected noxious via placenta/breast milk	Fetus/newborn affected by maternal use alcohol	10	P04.3
Fetus/newborn affected noxious via placenta/breast milk	Fetus/newborn affected by maternal use drugs	10	P04.4
Congenital malformations, deformations, etc.			
Other congenital malformations	Fetal alcohol syndrome (dysmorphic)	10	Q86.0
Symptoms, signs, etc. not elsewhere classified			
Findings of drugs and substances, not normally in blood	Finding of alcohol in blood	10	R78.0
Findings of drugs and substances, not normally in blood	Finding of opiate in blood	10	R78.1
Findings of drugs and substances, not normally in blood	Finding of cocaine in blood	10	R78.2
Findings of drugs and substances, not normally in blood	Finding of hallucinogen in blood	10	R78.3
Findings of drugs and substances, not normally in blood	Finding of other drug addictive potential in blood	10	R78.4
Findings of drugs and substances, not normally in blood	Finding of psychotropic drug in blood	10	R78.5

Injury, poisoning, other consequences of external causes			
Poisoning by drugs, medicaments, biological substances	by narcotics and psychodysleptics	10	T40
Poisoning by drugs, medicaments, biological substances	by barbiturates	10	T42.3
Poisoning by drugs, medicaments, biological substances	by benzodiazepines	10	T42.4
Poisoning by drugs, medicaments, biological substances	by other antiepileptic and sedative-hypnotic drugs	10	T42.6
Poisoning by drugs, medicaments, biological substances	by unspecified sedative-hypnotic drugs	10	T42.7
Poisoning by drugs, medicaments, biological substances	Poisoning by psychotropic drugs, other	10	T43
Poisoning by drugs, medicaments, biological substances	by alcohol deterrent	10	T50.6
Poisoning by drugs, medicaments, biological substances	by opiate antagonist	10	T50.7
Poisoning by drugs, medicaments, biological substances	Toxic effect of alcohol	10	T51
Poisoning by drugs, medicaments, biological substances	Toxic effect of organic solvents	10	T52
Poisoning by drugs, medicaments, biological substances	Toxic effect of aromatic hydrocarbons, etc. [CFCs]	10	T53
Poisoning by drugs, medicaments, biological substances	Toxic effect of other gases, fumes and vapours	10	T59
External causes of morbidity and mortality			
Accidental poisoning by noxious substances	by antiepileptic, sedative-hypnotic,psychotropic etc	10	X41
Accidental poisoning by noxious substances	by and exposure to narcotics and psychodysleptics	10	X42
Accidental poisoning by noxious substances	by alcohol	10	X45
Accidental poisoning by noxious substances	by organic solvents,hydrocarbons and their vapours	10	X46
Accidental poisoning by noxious substances	by other gases and vapours	10	X47
Intentional self-harm	by antiepileptic, sedative-hypnotic,psychotropic etc	10	X61
Intentional self-harm	by and exposure to narcotics and psychodysleptics	10	X62
Intentional self-harm	by alcohol	10	X65
Intentional self-harm	by organic solvents,hydrocarbons and their vapours	10	X66
Intentional self-harm	by other gases and vapours	10	X67
Event of undetermined intent	by antiepileptic, sedative-hypnotic,psychotropic etc	10	Y11
Event of undetermined intent	by and exposure to narcotics and psychodysleptics	10	Y12
Event of undetermined intent	by alcohol	10	Y15
Event of undetermined intent	by organic solvents,hydrocarbons and their vapours	10	Y16
Event of undetermined intent	by other gases and vapours	10	Y17
Supplementary factors related to causes of morbidity	Evidence of alcohol involvement, BAC	10	Y90
Supplementary factors related to causes of morbidity	Evidence of alcohol involvement, level intoxication	10	Y91
Factors influencing health status, health service contact			
Persons encountering health services, specific care	Alcohol rehabilitation	10	Z50.2
Persons encountering health services, specific care	Drug rehabilitation	10	Z50.3
Persons encountering health services, other circumstances	Alcohol abuse counselling and surveillance	10	Z71.4
Persons encountering health services, other circumstances	Drug abuse counselling and surveillance	10	Z71.5
Problems related to lifestyle	Alcohol use	10	Z72.1
Problems related to lifestyle	Drug use	10	Z72.2
Persons with potential health hazards	Personal history of psychoactive substance abuse	10	Z86.4

INJURY BY EXTERNAL CAUSES

Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
External causes (excl. poisoning & medical comp.)			
Accidents	Transport accidents	9	E800-E848
	Accidents in the home (all entries under 'place of occurrence' = home)		E849.0
	Accidents (falls, fire, natural factors, drowning, other)		E880-E929
Accidents	Transport accidents	10	V01-V99 Y85
	Accidents (falls, mechanical forces, fire, natural factors, drowning, other)		W00-X39 X50-X59 Y86
Undetermined intent	Injury undetermined if accidental or purposely inflicted (excl. poisoning)	9	E983-E989
Undetermined intent	Injury undetermined if accidental or purposely inflicted (excl. poisoning)	10	Y20-Y34 Y87.2
Legal intervention	Injury due to legal intervention (e.g. manhandling)	9	E970-E977
Legal intervention	Injury due to legal intervention (e.g. manhandling)	10	Y35 Y89
Assault (excl. poisoning)			
Assault	Injury purposely inflicted by other persons (excl. by poisoning)	9	E960-E961 E963-E969
Assault	Assault (excl. by poisoning)	10	X91-Y09 Y87.1

INFECTION RELATED HOSPITALISATION			
Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Infections (any)			
Infectious and parasitic diseases	Any hospitalisation	9	001-139
Infectious and parasitic diseases	Any hospitalisation	10	A00-B99
Respiratory system	Acute respiratory infections	9	460-466
Respiratory system	Acute respiratory infections	10	J00-J06
Respiratory system	Pneumonia and influenza	9	480-488
Respiratory system	Pneumonia and influenza	10	J09-J18
Factors influencing health service contact	Contact with and exposure to communicable diseases	9	V01
Factors influencing health service contact	Contact with and exposure to communicable diseases	10	Z20
Factors influencing health service contact	Carrier of infectious disease	9	V02
Factors influencing health service contact	Carrier of infectious disease	10	Z22
Factors influencing health service contact	Asymptomatic HIV status	9	V08
Factors influencing health service contact	Asymptomatic HIV status	10	Z21
Infections in pregnancy			
Complications related to pregnancy	Infections of the genitourinary tract in pregnancy	9	646.6
Complications related to pregnancy	Infections of the genitourinary tract in pregnancy	10	O23
Complications related to pregnancy	Infective and parasitic conditions in the mother	9	647
Complications related to pregnancy	Infective and parasitic conditions in the mother	10	O98
Complications related to pregnancy	Suspected fetal damage from maternal viral disease	10	O35.3
Certain conditions originating in the perinatal period	Fetus/newborn affected by maternal infectious and parasitic diseases	9	760.2
Certain conditions originating in the perinatal period	Fetus/newborn affected by maternal infectious and parasitic diseases	10	P00.2
Certain conditions originating in the perinatal period	Infections specific to the perinatal period	9	771
Certain conditions originating in the perinatal period	Infections specific to the perinatal period	10	P35-P39
Chronic and sexually transmitted infections			
Tuberculosis	Tuberculosis	9	010-018
Tuberculosis	Tuberculosis	10	A15-A19
HIV	HIV	9	042-044
HIV	HIV	10	B20-B24
Infections with a predominantly sexual mode of transmission	Syphilis and other venereal diseases	9	090-099
Infections with a predominantly sexual mode of transmission	Infections with a predominantly sexual mode of transmission	10	A50-A64
Herpes simplex	Herpes simplex	9	054
Herpes simplex	Herpes simplex	10	B00
Viral hepatitis	Viral hepatitis	9	070
Viral hepatitis	Viral hepatitis	10	B15-B19
Complications related to pregnancy	Infective/parasitic conditions in mother – Syphilis	9	647.0
Complications related to pregnancy	Infective/parasitic conditions in mother – Gonorrhea	9	647.1
Complications related to pregnancy	Infective/parasitic conditions in mother – Other venereal	9	647.2
Complications related to pregnancy	Infective/parasitic conditions in mother – Tuberculosis	9	647.3
Complications related to pregnancy	Infective/parasitic conditions in mother – Tuberculosis	10	O98.0
Complications related to pregnancy	Infective/parasitic conditions in mother – Syphilis	10	O98.1
Complications related to pregnancy	Infective/parasitic conditions in mother – Gonorrhea	10	O98.2
Complications related to pregnancy	Infective/parasitic conditions in mother – Other sexually trans.	10	O98.3
Complications related to pregnancy	Infective/parasitic conditions in mother – Viral hepatitis	10	O98.4
Complications related to pregnancy	Infective/parasitic conditions in mother – HIV	10	O98.7
Factors influencing health service contact	Asymptomatic HIV status	9	V08
Factors influencing health service contact	Asymptomatic HIV status	10	Z21
Factors influencing health service contact	Contact with or exposure to venereal diseases	9	V01.6
Factors influencing health service contact	Contact with or exposure to infections with sexual mode transmission	10	Z20.2
Factors influencing health service contact	Contact with or exposure to viral hepatitis	10	Z20.5
Factors influencing health service contact	Contact with or exposure to HIV	10	Z20.6
Factors influencing health service contact	Carrier of gonorrhoea	9	V02.7
Factors influencing health service contact	Carrier of other venereal diseases	9	V02.8
Factors influencing health service contact	Carrier of infections predominantly sexual mode	10	Z22.4
Factors influencing health service contact	Carrier of viral hepatitis	9	V02.6
Factors influencing health service contact	Carrier of viral hepatitis	10	Z22.5

MATERNAL MENTAL ILLNESS

Chapter / Diagnosis level 1	Diagnosis level 2	ICD	ICD codes
Mental Health Service Presentation			
Mental Health Service Presentation	Any MHIS contact (excl. substance-use related) ****exclude codes for alcohol or substances with abuse potential****	9-10	Any **exc. Drug/Alc**
Hospitalisation			
Mental and behavioural disorders	Any hospitalisation (excl. substance-use related) ****exclude codes for alcohol or substances with abuse potential****	9	290-319 **exc. Drug/Alc**
Mental and behavioural disorders	Any hospitalisation (excl. substance-use related) ****exclude codes for alcohol or substances with abuse potential****	10	F00-F99 **exc. Drug/Alc**
Factors influencing health service contact	Personal history of a mental disorder	9	V11
Factors influencing health service contact	Mental and behavioural problems	9	V40
Factors influencing health service contact	Screening for mental disorders	9	V79
Factors influencing health service contact	General psychiatric examination	10	Z00.4 Z04.6
Factors influencing health service contact	Observation for suspected mental disorder	10	Z03.2
Complications mainly relating to pregnancy	Mental disorders complicating pregnancy, etc.	9	648.4
Complications mainly relating to pregnancy	Mental disorders complicating pregnancy, etc.	10	O99.3
Self-harm (excl. poisoning)			
Self-inflicted injury	Suicide and self-inflicted injury (excl. by poisoning)	9	E953-E959
Self-inflicted injury	Suicide and self-inflicted injury (excl. by poisoning)	10	X70-X84 Y87.0

PREGNANCY COMPLICATIONS

Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Abruptio placentae & other placental disorders			
Complications mainly related to pregnancy	Abruptio placentae	9	641.2
Complications mainly related to pregnancy	Other placental conditions affecting management of the mother	9	656.7
Maternal care related fetus, amniotic cavity, possible delivery probs	Abruptio placentae	10	O45
Maternal care related fetus, amniotic cavity, possible delivery probs	Placental disorders	10	O43
Placenta previa			
Complications mainly related to pregnancy	Placenta previa	9	641.0-641.1
Maternal care related fetus, amniotic cavity, possible delivery probs	Placenta previa	10	O44
Premature Rupture of Membranes			
Other indications for care in pregnancy, labor, and delivery	Premature rupture of membranes	9	658.1
Maternal care related fetus, amniotic cavity, possible delivery probs	Premature rupture of membranes	10	O42

MULTIPLE GESTATION

Chapter	Diagnosis level 1	Diagnosis 2	ICD ed.	ICD codes
Complications of pregnancy, etc.	Normal delivery, etc.	Multiple gestation	9	651
Supplementary classification	Live-born infants according to type	Twin birth mates liveborn	9	V31
Supplementary classification	Live-born infants according to type	Other multiples	9	V32-V37
Pregnancy, childbirth, puerperium	Maternal care related to the fetus	Multiple gestation	10	O30
Pregnancy, childbirth, puerperium	Maternal care related to the fetus	Complications to multiple gestation	10	O31
Pregnancy, childbirth, puerperium	Delivery	Multiple delivery	10	O84

CHROMOSOMAL ABNORMALITIES

Chapter	Diagnosis level 1	ICD ed.	ICD codes
Complications of pregnancy, childbirth, puerperium	Chromosomal anomalies	9	655.1
Congenital anomalies	Chromosomal anomalies	9	758
Pregnancy, childbirth and the puerperium	Maternal care for (suspected) chromosomal abnorm. in fetus	10	O35.1
Congenital malform., deform. and chromosomal ab.	Chromosomal abnormalities	10	Q90-Q99

NON-SIGNIFICANT FACTORS
(Tested alone and in combination)

Chapter / Diagnosis level 1	Diagnosis level 2	ICD ed.	ICD codes
Cancer			
Neoplasms	Malignant neoplasms	9	140-208
Neoplasms	Malignant neoplasms	10	C00-C97
Neoplasms	Neoplasms of uncertain or unspecified nature	9	235-239
Neoplasms	Neoplasms of uncertain or unspecified nature	10	D37-D48
Anaemia			
Diseases of the blood and blood-forming organs	Anemia	9	280-285
Diseases of the blood and blood-forming organs	Anemia	10	D50-D64
Complications mainly related to pregnancy	Anemia complicating pregnancy	9	648.2
Complications mainly related to pregnancy	Anemia complicating pregnancy	10	O99.0
Nutritional deficiencies			
Endocrine, nutritional and metabolic diseases	Nutritional deficiencies	9	260-269
Endocrine, nutritional and metabolic diseases	Nutritional deficiencies	10	E50-E64
Malnutrition			
Endocrine, nutritional and metabolic diseases	Malnutrition	10	E40-E46
Maternal disorders related to pregnancy	Malnutrition in pregnancy	10	O25
Complications predominantly related to pregnancy	Maternal care for low weight gain in pregnancy	10	O26.1
Obesity			
Endocrine, nutritional and metabolic diseases	Obesity	9	278.0-278.1
Endocrine, nutritional and metabolic diseases	Obesity	10	E65-E66
Complications predominantly related to pregnancy	Maternal care for excessive weight gain in pregnancy	10	O26.0
Diabetes mellitus			
Endocrine, nutritional and metabolic diseases	Diabetes mellitus	9	250
Endocrine, nutritional and metabolic diseases	Diabetes mellitus	10	E10-E14
Complications mainly related to pregnancy	Diabetes mellitus in pregnancy	9	648.0
Complications mainly related to pregnancy	Diabetes mellitus in pregnancy	10	O24
Complications mainly related to pregnancy	Abnormal glucose tolerance complicating pregnancy	9	648.8
Certain conditions originating in the perinatal period	Syndrome of 'infant of a diabetic mother'	9	755.0
Abortion (miscarriage and induced)			
Complications of pregnancy	Ectopic and molar pregnancy	9	630-633
Complications of pregnancy	Other pregnancy with abortive outcome	9	634-639
Complications of pregnancy	Pregnancy with abortive outcome	10	O00-O08
Complications of pregnancy	Pregnancy care of habitual aborter	10	O26.2
Hypertension			
Complications mainly related to pregnancy	Hypertension complicating pregnancy, childbirth and the puerperium	9	642.0 642.2-642.3
Hypertensive disorders in pregnancy	Pre-existing hypertension complicating pregnancy, childbirth, puerperium	10	O10
Hypertensive disorders in pregnancy	Gestational hypertension	10	O13
Hypertensive disorders in pregnancy	Unspecified maternal hypertension	10	O16
Preeclampsia			
Complications mainly related to pregnancy	Preeclampsia	9	642.4-642.5
Complications mainly related to pregnancy	Preeclampsia or exclampsia superimposed on chronic hypertension	9	642.7
Hypertensive disorders in pregnancy	Preeclampsia superimposed on chronic hypertension	10	O11
Hypertensive disorders in pregnancy	Preeclampsia	10	O14
Eclampsia			
Complications mainly related to pregnancy	Eclampsia	9	642.6
Hypertensive disorders in pregnancy	Eclampsia	10	O15
Renal disease			
Genitourinary system	Renal failure	9	584-586
Genitourinary system	Renal failure	10	N17-N19
Factors influencing health service contact	Encounter for dialysis and dialysis catheter care	9	V56
Complications mainly related to pregnancy	Hypertension secondary to renal disease complicating pregnancy	9	642.1
Complications mainly related to pregnancy	Unspecified renal disease in pregnancy without mention of hypertension	9	646.2
Factors influencing health service contact	Care involving dialysis	10	Z49
Maternal care other conditions predominantly related to pregnancy	Pregnancy related renal disease	10	O26.83

Results of the multivariate regression conducted for each main grouping of variables to eliminate non-significant variables from inclusion in the final multivariate analysis.

Table F2 Regression models of infant mortality by group, Aboriginal children

Group 1 Demographic factors

Regression model of infant mortality, Indigenous children

	RR	[95%	CI]	*p*-value
Birth year	0.97	0.95	0.98	<.001
Sex				
Male	1.22	1.01	1.47	.040
Female*				
Maternal Indigenous status				
Indigenous	1.75	0.96	3.19	.066
Non-Indigenous*				
Socioeconomic status				
Very low (<5%)	2.06	1.31	3.25	.002
Low (6-25%)	1.93	1.24	2.99	.003
Medium (26-50%)	1.79	1.12	2.85	.015
High (51-100%)*				
Geographical remoteness				
Major cities and inner regional*				
Outer regional	1.10	0.84	1.45	.496
Remote	0.96	0.73	1.27	.793
Very remote	1.07	0.84	1.37	.578

* Reference category

Variables excluded from final multivariate model on basis of significance ($p>.05$)

\# Includes all other placental disorders except placenta previa.

Group 2 Baseline pregnancy risk factors

Regression model of infant mortality, Indigenous children

	RR	[95%	CI]	*p*-value
Multiple gestation				
Yes	2.36	1.57	3.57	<.001
No*				
Birth spacing				
<18months	1.62	1.26	2.08	<.001
Firstborn/18months+*				
Parity				
Nulliparous	0.92	0.73	1.16	.486
Parity 1-2				
Parity 3+	1.22	0.97	1.53	.091

* Reference category

Variables excluded from final multivariate model on basis of significance ($p>.05$)

Note. Maternal age was excluded prior to multivariate analysis as highly correlated with parity, which was more significant in univariate analysis

Group 3 Pregnancy complications

Regression model of infant mortality, Indigenous children

		RR	[95%	CI]	*p*-value
Abruptio placentae and other disorders[#]					
	Yes	3.73	1.89	7.34	<.001
	No*				
Placenta previa					
	Yes	2.10	0.69	6.42	.193
	No*				
Premature rupture of membranes					
	Yes	1.72	1.21	2.42	.002
	No*				
Infection related hospitalisation in pregnancy					
	Yes	0.99	0.70	1.40	.937
	No*				

* Reference category

Variables excluded from final multivariate model on basis of significance ($p>.05$)

[#] Includes all other placental disorders except placenta previa

Group 4 Other maternal factors/exposures in pregnancy

Regression model of infant mortality, Indigenous children

		RR	[95%	CI]	*p*-value
Substance use related service contact in pregnancy					
	Yes	1.99	1.17	3.36	.011
	No*				
Hospitalisation for external causes of injury in pregnancy					
	Yes	1.43	1.02	1.99	.038
	No*				
Mental health related service contact in pregnancy					
	Yes	0.70	0.39	1.27	.243
	No*				
Sibling in contact with Child Protection in pregnancy					
	Yes	1.97	1.36	2.86	<.001
	No*				

* Reference category

Variables excluded from final multivariate model on basis of significance ($p>.05$)

Appendix G Supplementary tables – Study V

Table G1 Maternal corrections (excluding offence type) predictors of low birth weight and infant mortality tested for Aboriginal infants

	Birth weight (n=779)						Infant mortality (n=802)					
	2500g+	<2500g					Sur.[#]	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Timing of imprisonment in pregnancy												
**Timing of first prison reception												
First reception prior to pregnancy start date	38	15	28.3	1.85	(0.96-3.58)	.066	54	<5		0.43	(0.06-3.30)	.415
First trimester (0-3 months)*	291	62	17.6				346	15	4.2			
Second or third trimester (4-9 months)	293	80	21.5	1.28	(0.89-1.85)	.188	375	11	2.9	0.68	(0.31-1.49)	.334
Timing of last prison discharge												
First trimester (0-3 months)	179	50	21.8	2.08	(1.08-4.03)	.029	225	10	4.3	1.61	(0.44-5.99)	.474
Second or third trimester (4-9 months)	346	94	21.4	2.03	(1.09-3.78)	.026	441	14	3.1	1.15	(0.33-4.09)	.825
Infant born in prison*	97	13	11.8				109	<5				
**Infant born in prison												
Yes*	97	13	11.8				109	<5				
No	525	144	21.5	2.05	(1.11-3.76)	.021	666	24	3.5	1.31	(0.39-4.43)	.665
Length of imprisonment in pregnancy												
Longest record of imprisonment												
0-13 days	323	99	23.5	2.50	(1.46-4.29)	.001	418	21	4.8	4.17	(0.97-18.00)	.056
14-59 days	152	40	20.8	2.15	(1.18-3.92)	.013	191	4	2.1	1.74	(0.31-9.62)	.527
60+ days*	147	18	10.9				166	<5				
**Total days imprisoned in pregnancy												
0-13 days	316	97	23.5	2.54	(1.50-4.30)	.001	410	20	4.7	2.89	(0.85-9.87)	.090
14-59 days	149	41	21.6	2.27	(1.26-4.10)	.006	187	4	2.1	1.27	(0.28-5.76)	.757
60+ days*	157	19	10.8				178	3	1.7			
Number of records within pregnancy												
**Community corrections records in pregnancy												
0*	255	59	18.8				317	14	4.2			
1	190	47	19.8	1.07	(0.70-1.64)	.759	233	9	3.7	0.87	(0.37-2.06)	.759
2+	177	51	22.4	1.25	(0.82-1.90)	.307	225	<5		0.40	(0.13-1.24)	.113
Prison records in pregnancy												
1	482	128	21.0	1.28	(0.82-2.00)	.274	606	24	3.8	2.23	(0.66-7.50)	.195
2+*	140	29	17.2				169	<5				

	Birth weight (n=779)						Infant mortality (n=802)					
	2500g+	<2500g					Sur.[#]	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Sentence type												
Sentence type of first prison record in pregnancy												
Sentenced*	154	35	18.5				191	6	3.1			
Unsentenced	285	80	21.9	1.24	(0.79-1.92)	.350	368	8	2.1	0.69	(0.24-2.02)	.502
Default of fine	183	42	18.7	1.01	(0.61-1.66)	.969	216	13	5.7	1.92	(0.71-5.14)	.197
**Sentence type of longest prison record in pregnancy												
Sentenced*	180	38	17.4				222	6	2.6			
Unsentenced	258	79	23.4	1.45	(0.94-2.23)	.091	228	8	2.3	0.88	(0.30-2.56)	.808
Default of fine	184	40	17.9	1.03	(0.63-1.68)	.907	215	13	5.7	2.24	(0.83-6.00)	.109
Combined measures with imprisonment length in pregnancy												
Number and length of prison records in pregnancy												
One record, <14 days	280	84	23.1	2.08	(1.13-3.83)	.019	361	19	5.0	5.89	(0.78-44.58)	.086
One record, 14+ days	202	44	17.9	1.51	(0.79-2.89)	.214	245	5	2.0	2.29	(0.26-19.82)	.453
Two or more records, all <14 days	43	15	25.9	2.42	(1.07-5.45)	.033	57	<5		3.93	(0.35-44.33)	.268
Two or more records, at least one 14+days*	97	14	12.6				112	<5				
Timing of first prison record in pregnancy and length of longest record of imprisonment in that period												
First trimester, <14 days	162	39	19.4	1.35	(0.77-2.38)	.298	193	13	6.3	5.15	(1.14-23.20)	.033
First trimester, 14+ days*	129	23	15.1				153	<5				
Time other than first trimester, <14 days	182	63	25.7	1.94	(1.14-3.29)	.014	248	9	3.5	2.78	(0.59-13.03)	.196
Time other than first trimester, 14+ days	149	32	17.7	1.20	(0.67-2.16)	.533	181	<5		1.27	(0.21-7.70)	.796
Sentence type/length longest prison record in pregnancy												
Sentenced (inc. fine default) <60 days	234	61	20.7	2.13	(1.21-3.75)	.009	288	17	5.6	4.90	(1.12-21.49)	.035
Unsentenced <60 days	241	78	24.5	2.64	(1.52-4.59)	.001	321	8	2.4	2.07	(0.43-9.86)	.362
60+ days*	147	18	10.9				166	<5				
**Sentence type/length longest prison record in pregnancy												
Sentenced (inc. fine default) 1-13 days	152	41	21.2	2.20	(1.21-4.01)	.010						
Unsentenced1-13 days	171	58	25.3	2.77	(1.56-4.91)	<.001						
Sentenced (inc. fine default) 14-59 days	82	20	19.6	1.99	(1.00-3.98)	.051						
Unsentenced 14-59 days	70	20	22.2	2.33	(1.16-4.69)	.017						
60+ days*	147	18	10.9									

	Birth weight cont.						Infant mortality cont.					
	2500g+	<2500g					Sur.[#]	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Release type												
Likelihood of continued supervision by corrective services after last release in pregnancy												
Unsupervised (e.g. freedom, bail, suspended sentence, fine)	467	118	20.2	1.05	(0.69-1.61)	.806	582	24	4.0	2.47	(0.74-8.32)	.143
Supervised (e.g. parole, community order)*	146	35	19.3				180	<5				
**Last release type in pregnancy 'Fine paid/Fined ex-court'												
Yes	59	20	25.3	1.41	(0.82-2.43)	.212	73	11	13.1	6.49	(2.90-14.52)	<.001
No*	554	133	19.4				689	16	2.3			
Prison facility location												
**Prison location of first imprisonment in pregnancy												
Metropolitan*	445	113	20.3				557	18	3.1			
Regional	177	44	19.9	0.98	(0.66-1.45)	.915	218	9	4.0	1.28	(0.57-2.89)	.556
Mother's history of contact with corrective services												
Imprisoned within 2-years before start of pregnancy												
Yes	375	94	20.0	0.98	(0.69-1.41)	.924	465	17	3.5	1.13	(0.51-2.51)	.758
No*	247	63	20.3				310	10	3.1			
Imprisoned within 1-year before start of pregnancy												
Yes	327	82	20.1	0.99	(0.69-1.40)	.939	402	15	3.6	1.16	(0.54-2.51)	.707
No*	295	75	20.3				373	12	3.1			
Community order within 2-years before start of pregnancy												
Yes	390	97	19.9	0.96	(0.67-1.38)	.832	486	16	3.2	0.86	(0.40-1.89)	.716
No*	232	60	20.6				289	11	3.7			
Community order within 1-year before start of pregnancy												
Yes	346	83	19.4	0.89	(0.63-1.27)	.535	426	12	2.7	0.66	(0.30-1.42)	.284
No*	276	74	21.1				349	15	4.1			
Corrections record within 2-years before start of pregnancy												
Yes	473	123	20.6	1.14	(0.75-1.74)	.544	591	22	3.6	1.37	(0.51-3.67)	.531
No*	149	34	18.6				184	5	2.7			
Corrections record within 1-year before start of pregnancy												
Yes	440	115	20.7	1.13	(0.76-1.68)	.535	546	19	3.4	1.00	(0.43-2.31)	.993
No*	182	42	18.8				229	8	3.4			

	Birth weight cont.						Infant mortality cont.					
	2500g+	<2500g					Sur.[#]	Died				
	n	n	%	OR	(95% CI)	*p*-value	n	n	%	OR	(95% CI)	*p*-value
Prison records within 2-years before start of pregnancy												
0*	247	63	20.3				310	10	3.1			
1	144	30	17.2	0.82	(0.50-1.32)	.410	175	5	2.8	0.89	(0.30-2.63)	.827
2+	231	64	21.7	1.09	(0.73-1.61)	.679	290	12	4.0	1.28	(0.55-3.02)	.568
Prison records within 1-year before start of pregnancy												
0*	295	75	20.3				373	12	3.1			
1	176	40	18.5	0.89	(0.58-1.37)	.607	215	7	3.2	1.01	(0.39-2.61)	.980
2+	151	42	21.8	1.09	(0.71-1.67)	.679	187	8	4.1	1.33	(0.53-3.31)	.540
Was imprisonment in pregnancy mother's first ever												
Yes*	179	43	19.4				223	5	2.2			
No	443	114	20.5	1.07	(0.72-1.58)	.731	552	22	3.8	1.78	(0.66-4.76)	.252
Age of mother at first ever imprisonment												
Juvenile	212	56	20.9	1.07	(0.74-1.55)	.709	267	7	2.6	0.67	(0.28-1.60)	.362
Adult*	410	101	19.8				508	20	3.8			
Age of mother at first ever corrections record												
Juvenile	261	68	20.7	1.06	(0.74-1.51)	.760	327	8	2.4	0.58	(0.25-1.33)	.199
Adult*	361	89	19.8				448	19	4.1			

 # Infant survived to 12-months
*** Reference category**
**** Included in Chapter 8 Table 1**

Table G2 Offence type predictor variables tested for Aboriginal and non-Aboriginal infants

	Non-Aboriginal		Aboriginal			
	Low birth weight		Low birth weight		Infant mortality	
	Prison[1] OR (95% CI)	Corrections[2] OR (95% CI)	Prison[1] OR (95% CI)	Corrections[2] OR (95% CI)	Prison[1] OR (95% CI)	Corrections[2] OR (95% CI)
Offences against the person						
Pregnancy	0.73 (0.21-2.60)	0.70 (0.23-2.15)	0.73 (0.46-1.15)	0.62** (0.41-0.93)	0.94 (0.39-2.27)	0.90 (0.39-2.08)
Before birth	0.51 (0.17-1.53)	0.53 (0.19-1.45)	0.67** (0.46-0.99)	0.76 (0.53-1.08)	1.05 (0.49-2.28)	1.12 (0.52-2.42)
Theft and related offences						
Pregnancy	0.69 (0.28-1.72)	0.78 (0.34-1.79)	1.12 (0.76-1.66)	0.98 (0.69-1.40)	0.21** (0.06-0.70)	0.19** (0.06-0.55)
Before birth	0.71 (0.31-1.61)	0.70 (0.32-1.53)	1.08 (0.74-1.58)	1.09 (0.74-1.62)	0.59 (0.27-1.27)	0.57 (0.26-1.25)
Drug offences						
Pregnancy	0.63 (0.18-2.22)	0.70 (0.23-2.15)	0.42 (0.05-3.29)	0.42 (0.10-1.85)	-	-
Before birth	1.04 (0.40-2.73)	0.76 (0.32-1.80)	0.49 (0.15-1.65)	0.47* (0.22-1.00)	0.88 (0.12-6.76)	0.36 (0.05-2.67)
Traffic offences						
Pregnancy	1.18 (0.33-4.31)	1.19 (0.38-3.72)	0.87 (0.49-1.52)	0.84 (0.50-1.39)	0.74 (0.22-2.51)	0.68 (0.20-2.29)
Before birth	2.07 (0.80-5.33)	1.35 (0.58-3.15)	0.81 (0.51-1.26)	0.89 (0.60-1.31)	1.05 (0.44-2.53)	0.95 (0.41-2.21)
Fraud offences						
Pregnancy	1.51 (0.53-4.35)	1.38 (0.55-3.47)	1.13 (0.37-3.46)	1.01 (0.43-2.36)	2.78 (0.61-12.60)	1.67 (0.40-7.35)
Before birth	1.31 (0.52-3.30)	1.48 (0.68-3.23)	1.20 (0.60-2.40)	0.76 (0.45-1.29)	3.69** (1.42-9.57)	2.47** (1.05-5.77)
Public order offences						
Pregnancy	1.49 (0.17-13.34)	0.78 (0.10-6.35)	2.58** (1.44-4.63)	1.83** (1.09-3.06)	2.10 (0.70-6.30)	1.55 (0.52-4.61)
Before birth	1.12 (0.24-5.26)	0.43 (0.10-1.92)	2.14** (1.39-3.31)	1.44* (1.00-2.09)	2.02 (0.86-4.73)	1.56 (0.71-3.41)
Breach of justice procedures						
Pregnancy	1.76 (0.69-4.51)	2.09* (0.87-4.99)	0.72 (0.43-1.20)	0.73 (0.47-1.15)	2.15* (0.94-4.90)	2.43** (1.11-5.34)
Before birth	0.97 (0.40-2.33)	1.09 (0.49-2.44)	1.37 (0.94-2.01)	1.24 (0.87-1.77)	2.28** (1.04-4.99)	2.18* (0.97-4.92)

Statistical significance: *p<.1 **p<.05 ***p<.001

'Corrections' includes prison records and community orders.

Sample size: Non-Aboriginal n=245; Aboriginal low birth weight n=779 and infant mortality n=802

[1] Infants missing maternal offence type: Non-Aboriginal 19 during pregnancy & 15 before birth; Aboriginal 96 during pregnancy & 79 before birth

[2] Infants missing maternal offence type: Non-Aboriginal 6 during pregnancy & 4 before birth; Aboriginal 31 during pregnancy & 14 before birth

Table G3 Summary of pairwise correlations with Cramer's V above threshold (>0.3 for 2-rows, or equivalent for 3+-rows)

Variable 1	Variable 2	Min. rows	Cramer's V	Correlation
Child birth year	Remoteness**	3	0.2372	Moderately Strong - Strong
Child birth year	Birth spacing	3	0.2376	Moderately Strong - Strong
Child birth year	Maternal age	3	0.2784	Strong - Very Strong
Child birth year	Parity	3	0.2778	Strong - Very Strong
Child birth year	Sibling contact with CP***	2	0.3005	Moderately Strong
Child birth year	Days imprisoned in pregnancy	3	0.2204	Moderately Strong - Strong
Child birth year	Community orders in pregnancy	3	0.3099	Very strong - Worrisomely Strong
Child birth year	Sentence type	3	0.4022	Worrisomely Strong
Child birth year	Offence: Person/prison**	2	0.3610	Strong
Child birth year	Offence: Public order/prison preg.**	2	0.3354	Moderately Strong - Strong
Socioeconomic status	Born in prison	2	0.4899	Very Strong - Worrisomely Strong
Socioeconomic status	Days imprisoned in pregnancy	2	0.3299	Moderately Strong - Strong
Birth spacing	Maternal age	3	0.3305	Very Strong - Worrisomely Strong
Birth spacing	Parity	3	0.7106	Worrisomely Strong
Birth spacing	Sibling contact with CP***	2	0.3331	Moderately Strong - Strong
Birth spacing	Child birth year	3	0.2376	Moderately Strong - Strong
Maternal age	Parity	3	0.3425	Very Strong - Worrisomely Strong
Maternal age	Community orders in pregnancy	3	0.3066	Very Strong - Worrisomely Strong
Maternal age	Prison facility location in pregnancy	2	0.3019	Moderately Strong
Maternal age	Sentence type	3	0.3363	Very Strong - Worrisomely Strong
Maternal age	Child birth year	3	0.2784	Strong - Very Strong
Maternal age	Birth spacing	3	0.3305	Very Strong - Worrisomely Strong
Parity	Sibling contact with CP***	2	0.3472	Moderately Strong - Strong
Parity	Offence: Traffic/prison****	2	0.3122	Moderately Strong - Strong
Parity	Child birth year	3	0.2778	Strong - Very Strong
Parity	Birth spacing	3	0.7106	Worrisomely Strong
Born in prison	Days imprisoned in pregnancy	2	0.5488	Worrisomely Strong
Born in prison	Sentence type	2	0.4863	Very Strong - Worrisomely Strong
Born in prison	Socioeconomic status	2	0.4899	Very Strong - Worrisomely Strong

Variable 1	Variable 2	Min. rows	Cramer's V	Correlation
Days imprisoned in pregnancy	Sentence type	3	0.4735	Worrisomely Strong
Days imprisoned in pregnancy	Child birth year	3	0.2204	Moderately Strong - Strong
Days imprisoned in pregnancy	Socioeconomic status	2	0.3299	Moderately Strong - Strong
Days imprisoned in pregnancy	Born in prison	2	0.5488	Worrisomely Strong
Community orders in pregnancy	Sentence type	3	0.2499	Strong
Community orders in pregnancy	Child birth year	3	0.3099	Very strong - Worrisomely Strong
Community orders in pregnancy	Maternal age	3	0.3066	Very Strong - Worrisomely Strong
Sentence type	Offence: Traffic/prison****	2	0.3180	Moderately Strong - Strong
Sentence type	Release type related to "fine"	2	0.3983	Very Strong
Sentence type	Child birth year	3	0.4022	Worrisomely Strong
Sentence type	Maternal age	3	0.3363	Very Strong - Worrisomely Strong
Sentence type	Born in prison	2	0.4863	Very Strong - Worrisomely Strong
Sentence type	Days imprisoned in pregnancy	3	0.4735	Worrisomely Strong
Sentence type	Community orders in pregnancy	3	0.2499	Strong
Sentence type + Days (combined)*	Child birth year	5	0.3379	Worrisomely Strong
Sentence type + Days (combined)*	Socioeconomic status	2	0.3541	Strong
Sentence type + Days (combined)*	Maternal age	3	0.3611	Worrisomely Strong
Sentence type + Days (combined)*	Born in prison	2	0.5546	Worrisomely Strong
Sentence type + Days (combined)*	Community orders in pregnancy	3	0.2480	Strong
Sentence type + Days (combined)*	Release type related to "fine"	2	0.3493	Strong

Reference: Cohen 1988, p.222

*** 'Sentence type + Days (combined)' was retained as it had the strongest univariate association with low birth weight of all correlated variables**

**** Denotes other variables that were able to be retained after exclusion of variables correlated with 'Sentence type + Days (combined)'**

***** 'Sibling contact with CP' was retained over 'Parity' and 'Birth spacing' as it had a stronger univariate association with low birth weight.**

****** Denotes other variable that was able to be retained after exclusion of 'Parity'.**

Table G4 Comparison of days of imprisonment in pregnancy for infants born in prison, and low birth weight

	1-13 days		14-59 days		60+ days	
	n	%	n	%	n	%
All infants*						
Not born in prison	408	61.0	171	25.6	90	13.5
Born in prison	5	4.5	19	17.3	86	78.2
Low birth weight						
Not born in prison	95	66.0	39	27.1	10	6.9
Born in prison	<5		<5		9	69.2
Normal/high weight						
Not born in prison	313	59.6	132	25.1	80	15.2
Born in prison	<5		17	17.5	77	79.4

***p*>0.001**

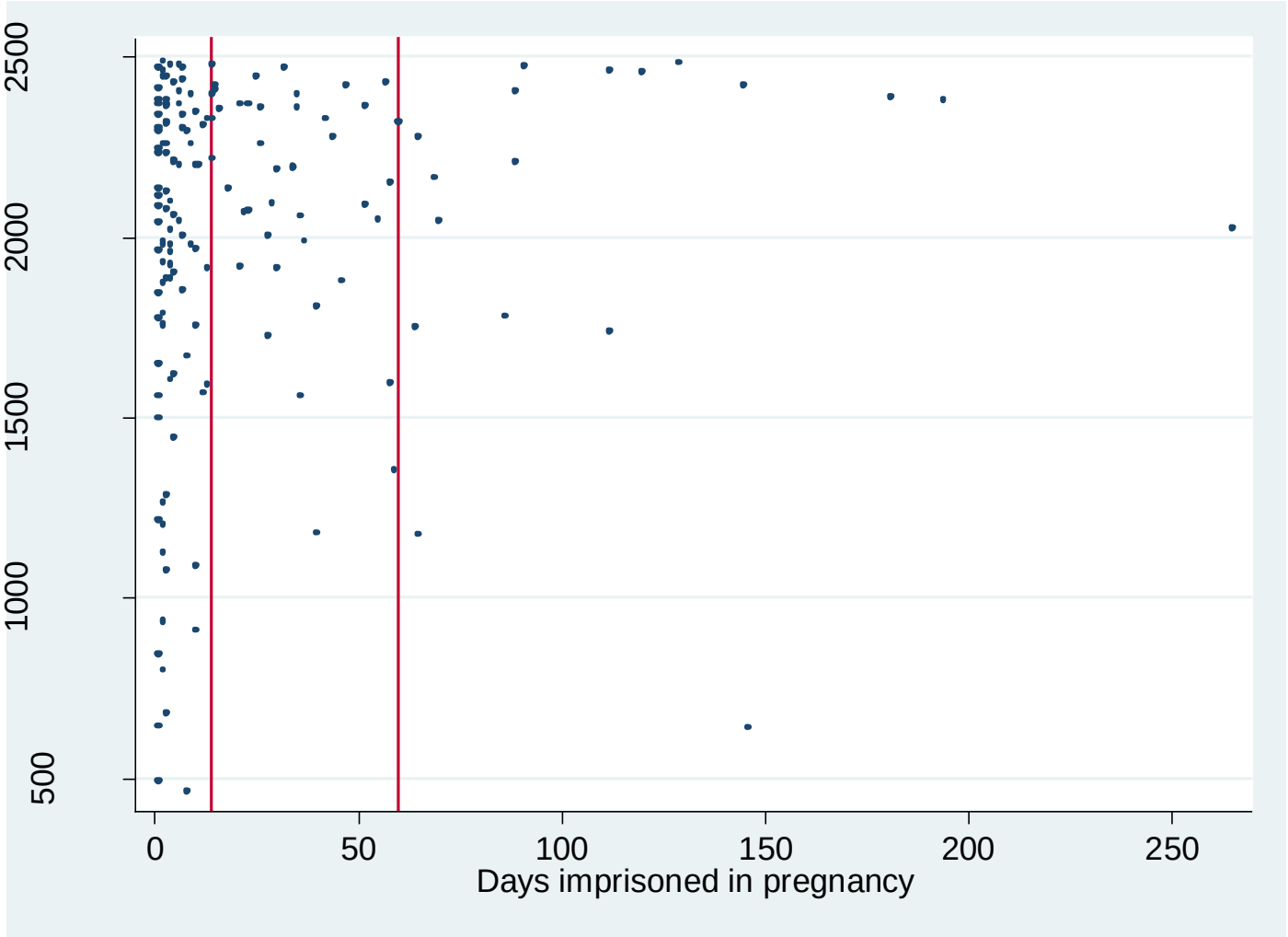


Figure G1 Birth weight by days mother imprisoned during pregnancy, for low birth weight cases (reference lines at 14 and 60 days)

Appendix H Cause and timing of infant death

The Death Registrations use the International Classification of Diseases (ICD), to classify cause of death. Over the study period, the ICD 9th Revision with Clinical Modification (ICD-9-CM) [19] related to services contacts before July 1999, and service contacts from that date used ICD 10th Revision with Australian Modification (ICD-10-AM) [20].

There were 69 infant death records (12.6%) missing a cause of death code. Of these, 38 had a cause of death text description enabling their classification, and 31 (5.7%) were completely missing cause of death data. Table 1 displays missingness of cause of death data by maternal corrections histories subgroups. Missingness was a problem for non-Aboriginal infants whose mothers were imprisoned during pregnancy.

Table H1 Infant mortality cases missing cause of death data, by maternal corrections history and Aboriginal status

	Aboriginal infants, n=430					Non-Aboriginal infants, n=116				
	Miss*	COD				Miss*	COD			
Maternal Corrections	n	n	RR	(95% CI)	*p*	n	n	RR	(95% CI)	*p*
Prison (before pregnancy)	<5	63	0.57	(0.13-2.64)	0.479	0	6			
Prison (during pregnancy)	0	27				<5	<5	7.50	(1.40-40.18)	0.019
Prison (after birth only)	6	80	1.31	(0.47-3.65)	0.607	<5	35	1.18	(0.28-5.00)	0.818
Community corrections	6	96	1.10	(0.39-3.08)	0.852	<5	9	1.50	(0.19-12.09)	0.703
No corrections*	8	142				<5	56			

***Missing. Note: Prison during pregnancy omitted from regression for Aboriginal analysis.**

Cause of death were classified by 11 categories (Table 2) based on ICD classification, and these were separated broadly into two-categories of causes originating in the perinatal period or postnatally.

Table 2 summarises detailed cause of death by Aboriginal status. Notably infections (not originating in the perinatal period) were a significant cause of Aboriginal infant death, and not for non-Aboriginal infants.

Table H2 Detailed cause of death, by Aboriginal status

Cause of death	Aboriginal infants, n=408 n	%	Non-Aboriginal infants, n=107 n	%
Perinatal causes	164	40.2	59	55.1
Congenital malformations & deformations	*47*	*11.5*	*18*	*16.8*
Disorders related to fetal growth & gestation	*33*	*8.1*	*9*	*8.4*
Respiratory & cardiovascular disorders specific to the perinatal period	*32*	*7.8*	*13*	*12.2*
Perinatal conditions related to maternal factors & pregnancy/delivery complications	*22*	*5.4*	*10*	*9.4*
Infections specific to the perinatal period	*13*	*3.2*	*<5*	
Other disorders originating in the perinatal period	*10*	*2.5*	*5*	*4.7*
Haemorrhagic/cerebral disorders originating in the perinatal period	*7*	*1.7*	*<5*	
Postnatal causes	244	59.8	48	44.9
Sudden Infant Death Syndrome	*129*	*31.6*	*39*	*36.5*
Infections (not originating in the perinatal period)	*81*	*19.9*	*0*	
External causes	*22*	*5.4*	*7*	*6.5*
Diseases (not originating in the perinatal period)	*12*	*2.9*	*<5*	

Notes. Excludes 31 missing cause of death data.

Table H3 Cause of death, by maternal corrections history and Aboriginal status

	Aboriginal infants, n=408						Non-Aboriginal infants, n=107					
Maternal Corrections History	Perinatal n	Postnatal n	%	RR	(95% CI)	*p*-value	Perinatal n	Postnatal n	%	RR	(95% CI)	*p*-value
Prison (before, not during, pregnancy)	22	41	65.1	1.17	(0.93-1.48)	0.187	<5	<5		2.20	(1.10-4.38)	0.026
Prison (during pregnancy)	10	17	63.0	1.13	(0.82-1.57)	0.455	0	<5				
Prison (after birth only)	22	58	72.5	1.30	(1.07-1.59)	0.009	15	20	57.1	1.88	(1.15-3.08)	0.011
Community corrections	47	49	51.0	0.92	(0.72-1.17)	0.490	<5	6		2.20	(1.19-4.04)	0.011
No corrections*	63	79	55.6				39	17	30.4			

Notes. Excludes 31 missing cause of death data. Prison during pregnancy omitted from non-Aboriginal analysis and table.

Also apparent in Table 2 is the difference between perinatal and postnatal causes between the Aboriginal and non-Aboriginal samples, with Aboriginal infants having a higher proportion of postnatal causes.

Table 3 summarises the proportion of infant deaths by postnatal causes for Aboriginal and non-Aboriginal infants by maternal corrections subgroups. For Aboriginal infants, the risk of postnatal causes was higher for all prison subgroups relative to no maternal corrections, however, the difference was only significant for the group with first record of maternal imprisonment after birth. For non-Aboriginal infants, all groups with maternal corrections history (excluding prison during pregnancy due to missingness of cause of death) had significantly higher postnatal causes of death than infants with no maternal corrections history.

Greater post-neonatal mortality (death after 28-days) is generally associated with higher disadvantage in a population. As infant birth date was obtained to month of birth only, it was not possible to determine the exact age of infant at time of death. The minimum and maximum age (in days) of infant at time of death, were able to be determined using full death date (DD/MM/YYYY) and month of birth. These are summarised in Table 4 by maternal corrections history subgroups and Aboriginal status. The minimum and maximum median ages at time of death did not differ significantly between maternal corrections subgroups.

Table H4 Median age at time of infant death (days), by maternal corrections history and Aboriginal status

	Aboriginal infants, n=430			Non-Aboriginal infants, n=116		
Maternal Corrections History	Deaths n	Days (min.) Median (IQR)	Days (max.) Median (IQR)	Deaths n	Days (min.) Median (IQR)	Days (max.) Median (IQR)
Prison (before, not during, pregnancy)	65	29 (1-84)	58 (29-114)	6	16 (1-61)	46 (27-91)
Prison (during pregnancy)	27	35 (1-129)	65 (23-158)	<5	29 (1-57)	51.5 (19-84)
Prison (after birth only)	86	26.5 (1-92)	56 (22-122)	38	1 (1-70)	28 (18-99)
Community corrections	102	5 (1-77)	35 (20-106)	10	24 (1-47)	54 (28-76)
No corrections*	150	31.5 (1-121)	61.5 (24-151)	60	1 (1-42)	27 (22.5-71.5)

Notes. Median days and Kruskal-Wallis equality-of-populations rank test used as distributions not normally distributed.
No significant differences between maternal corrections populations using Kruskal-Wallis equality-of-populations rank test:
Aboriginal min. days, chi-square 6.213(4df) p=0.1838
Aboriginal max. days, chi-square 5.358(4df) p=0.2525
Non-Aboriginal min. days, chi-square 3.457(4df) p=0.4844
Non-Aboriginal max. days, chi-square 2.704(4df) p=0.6080

Appendix I Peer-reviewed and published works contained in the thesis

Quantifying maternal incarceration: a whole-population linked data study of Western Australian children born 1985–2011

Caitlin M. Dowell,[1] David B. Preen,[2] Leonie Segal[1]

Abstract

Objective: To measure the prevalence of children affected by maternal incarceration in Western Australia (WA).

Methods: Using linked administrative data we identified all children born in WA between 1985 and 2011, whose biological mother was imprisoned during their childhood. Data was obtained through the WA Data Linkage Branch from the Department of Corrective Services, Midwives Notifications System and Birth Registrations data collections. Descriptive characteristics of the children (n=9,352) and their mothers (n=3,827) are reported. Prevalence was measured in two-ways, the proportion of children ever affected in childhood and affected annually.

Results: Childhood prevalence of maternal incarceration was 26-times higher (95%CI 23.9-28.2) for Indigenous children born 1992-1996 with 18.8% Indigenous children and 0.7% non-Indigenous children affected while aged 0-17 years. On average 1,544 children were affected each year across 2003-2011, at rates of 2,929 per 100,000 Indigenous children and 108 per 100,000 non-Indigenous children.

Conclusions: The findings present the first census of children affected by maternal incarceration within an Australian State and identify a large disparity between Indigenous and non-Indigenous populations.

Implications for public health: This study highlights the importance of formal consideration of children of women prisoners in the development of criminal justice policies and practices.

Key words: children, maternal incarceration, prison, prevalence, linked data

Children of incarcerated parents are a uniquely vulnerable group. Exposed to a range of disadvantage within their family environment in such forms as domestic violence, parental mental health and substance use issues,[1,2] they face additional difficulties through parental incarceration with disruption of care arrangements,[3,4] financial impacts,[5] stigmatisation,[6] and psychological distress.[7,8]

While debate exists over whether parental incarceration has any causal effect on child outcomes, over-and-above the effect of family environments,[9,10] the literature has consistently found children of prisoners experience a range of problems. These issues include internalising and externalising behaviour problems,[11] poor developmental outcomes,[12] academic difficulties, lower rates of school completion,[13] delinquency,[14,15] and child mortality.[16]

Regardless of causality, children of prisoners are a vulnerable population with complex needs that warrant tailored attention. However, children of prisoners have received little attention from government. They are not the core business of any one department and instead intersect with numerous services including child protection, health, education and corrections. Currently services for Australian children of prisoners are provided on an ad hoc basis and vary considerably between States, Territories and prisons.[17]

This population is particularly invisible in their absence from any official statistical reporting.[18] A small number of estimates of the proportion of prisoners who are parents exist from prisoner survey data,[2,19] and few studies have estimated the extent of children affected from prisoner surveys based on a range of assumptions.[18,20]

Without a clear picture of the number of children experiencing parental incarceration and a description of their basic characteristics, it is impossible to deliver appropriate services or to consider their needs in the development of criminal justice policies.

Children of incarcerated mothers face a unique set of circumstances in addition to those relating to paternal incarceration. Incarcerated mothers are more likely to have been the primary or sole child-caregiver prior to imprisonment.[21] For young children this may contribute to disruption of secure attachment if mother-baby facilities are not available in correctional facilities.[12] Although the absolute numbers of women prisoners are low compared to men, the female prison population is growing at a faster rate.[22]

Indigenous women are the fastest growing prison population within Australia.[23] Many Indigenous Australians experience worse health and social outcomes than non-Indigenous Australians, resulting from a long-history of systemic discrimination including land dispossession and the forced separation of Indigenous children from their families.[24] The imprisonment of Indigenous mothers is a particularly important issue given the

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propensity for this to continue disruption of Aboriginal families and culture for future generations.

In this context, the objective of the current study was to describe the size and extent of the Western Australian (WA) population affected by the incarceration of their mother during childhood, with a particular focus on differences between Indigenous and non-Indigenous populations.

Methods

Cohort selection

The cohort included all children born in WA between 1 January 1985 and 31 December 2011 whose biological mother had at least one custodial record in a WA prison during their childhood (0-17 years inclusive) to 31 December 2014. This included mothers who were unsentenced remandees or juveniles held in custody.

A custodial record was defined by any entry in the WA Total Offender Management Solution (TOMS) system. The TOMS system is maintained by the WA Department of Corrective Services (DCS) and includes all custodial records within WA. It excludes unsentenced individuals detained in holding cells within police stations and courts, immigration detention centres, and mental health facilities. Mothers with community corrections orders but no custodial record were excluded from the study population.

Data linkage and extraction

The identification of the study population and extraction of links for project data were performed by the WA Data Linkage Branch. The Data Linkage Branch maintains the Western Australian Data Linkage System (WADLS). The WADLS uses computerised probabilistic matching with clerical review to establish a master linkage key between WA administrative data collections.[25] The linkage process is highly accurate, with 99.89% of links estimated as valid.[25] Linkage between DCS and other WADLS data collections has previously been performed for offender health research.[26-28] Indigenous status for mothers and children was provided through the WADLS using best-practice algorithms,[29] which derive Indigenous status across multiple data collections to reduce missing data and improve consistency.

Children's records were extracted from the Birth Registrations and Midwives Notification System data collections. Data were available from both sources for the period of January 1985 to December 2011. Data on mothers were extracted from the DCS data collection and restricted to prison records on or before 31 December 2014. Erroneous records in which the prison reception and discharge date-time were identical (n=67) were excluded. For prison records not discharged by the date of data extraction (28 August 2015, n=68), a censoring date of 28 August 2015 was assigned for the calculation of child age and length of imprisonment.

Study subgroup observations within the total cohort

As the cohort was born between 1985-2011, data were available for various lengths of time for individual cohort members. Accordingly analyses drew on different subgroups of data, as outlined in Table 1.

Analyses

Cohort description

Descriptive statistics for children were calculated, including Indigenous status, sex, age and socioeconomic status. Birth-date and sex were derived from Birth Registration data, or Midwives Notifications System data if birth data were unavailable.

Descriptive information on mothers were derived from the data, including Indigenous status, age at imprisonment, number of cohort children, number and length of imprisonment terms, whether they were sentenced or unsentenced, and offence type.

Annual prevalence

Annual age-standardised rates of Indigenous and non-Indigenous WA children who experienced maternal incarceration while aged 0-17 years in 2003-2011, 0-9 years in 1995-2011 and 0-4 years in 1990-2011 (see Table 1), were calculated using population denominators derived from the Australian Bureau of Statistics (ABS).[30,31] The rate of children aged 0-15 years affected by maternal incarceration in 2001 was calculated separately for comparison with existing New South Wales (NSW) estimates.[20]

Childhood prevalence

Prevalence of children who experienced maternal incarceration during childhood from birth to age 17 years, nine years and four years was calculated by birth years from 1985 to 1996, 2004 and 2009 respectively (see Table 1). Population denominators comprised the total number of live births in WA per year.[32] This analysis was stratified by Indigenous status for children born from 1992 onwards as WA Indigenous birth registration data are only available from 1992.[29]

Average annual percentage change in the rate of children affected across each time period was calculated using the following equation:

$$\frac{\left(\sum_{i=2}^{n} \frac{Rate_{Year\ i}}{Rate_{year\ i-1}} - 1\right) \times 100}{n-1}$$

Where *n* is the total number of years, Year 1 is the first year and Year *n* is the last year.[33]

Proportion of WA female prisoners who are mothers

The proportion of women prisoners who are mothers (of children aged 0-17 years) at the time of their incarceration was calculated from the total number of female prisoners in WA identified in the ABS Prisoner Census for years 2003-2011.[22] The Prisoner Census is taken on 30 June each year, it includes all women remanded or sentenced to adult custodial corrective services in WA on that day. The number of mothers in prison on 30 June each year was calculated using mother's reception and discharge dates in the DCS data. Mothers in juvenile custodial facilities were excluded as they are not included in the Prisoner Census.[22]

Table 1: Study subgroup observations within the total cohort.

Analysis	Child birth years	Data observation period	Child age at time of maternal incarceration
Cohort description (total cohort)	1985-2011	1985-2014	0-17 years
Childhood prevalence[a]	1985-1996	1985-2014	0-17 years
	1985-2004	1985-2014	0-9 years
	1985-2009	1985-2014	0-4 years
Annual prevalence	1985-2011	2003-2011	0-17 years
	1985-2011	1995-2011	0-9 years
	1985-2011	1990-2011	0-4 years
Proportion of mother prisoners[b]	1985-2011	2003-2011	0-17 years

a: Indigenous status for WA population birth data only available from 1992

b: Point in time estimate on 30 June annually.

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Socioeconomic status classification

The Socioeconomic Indexes for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage (IRSD)[34] was used to assign area-based socioeconomic status of children's place of residence at time of birth. The IRSD score is a continuum where lower scores equate to relatively more measures of economic and social disadvantage within an area.

The smallest area of SEIFA reporting is Collectors District (CD) level, which is about 250 households or less in rural areas.[34] CD level scores were missing for 9.3% of the cohort. CD level is not available for certain areas, for example where low census response rates would jeopardise the representativeness of respondents.[35] Other examples for exclusion include very low levels of employment or where income could not be calculated in 70% or more households.[35] Missingness is therefore likely to be associated with disadvantage. For this reason, missing CD scores were first replaced with mean CD-score by postcode (7.9%) before using broader area scores of SEFIA available for Statistical Local Area or Local Government Area (1.1%).

Offence type classification

TOMS data provided the major offence type for prisoners using the Australian Standard Offence Classification (ASOC).[36] The ASOC classifies offences within 16 Divisions using criteria based on the use of violence, aim, victim, seriousness and intent.[36]

Statistical analyses

Statistical analyses were undertaken in Stata version 14.0. Difference between Indigenous and non-Indigenous children and mothers' demographic characteristics were assessed using the Mann-Whitney test for continuous variables and a Pearson's chi-square for categorical variables.

Assumptions for the Mann-Whitney test were met as the dependent variables were ordinal or continuous, the independent variable consists of two independent groups, observations were independent, and all variables were not normally distributed as established from skewness and kurtosis tests for normality.[37]

Continuous variables were divided into categories to better describe the spread of the data. Pearson's chi-square test was used to assess differences between Indigenous and non-Indigenous groups for categorical variables. All assumptions for Pearson's chi-square test were met as observations were independent from each other and all cells had expected counts above five.[38]

Ethics approvals

Ethics approvals were obtained from the Department of Health Human Research Ethics Committee, the Western Australian Aboriginal Health Ethics Committee, and the University of South Australia Human Research Ethics Committee.

Results

Table 2 summarises the characteristics of the cohort children. In total 9,352 children who were born in WA between 1985 and 2011 had their biological mother incarcerated at least once by December 2014. Approximately two-thirds of the cohort were Indigenous. Indigenous children (Mdn age = 4.2 years) were younger than non-Indigenous children (Mdn age = 5.1 years) at first exposure to their mother's imprisonment, U= 7.11, p<0.0001. Half of all cohort children were first exposed by the age of four. Over half of the children were living in the 20% most disadvantaged areas. More Indigenous children were in the most disadvantaged areas, χ^2 (4, N = 9326) = 692.38, p<0.0001.

Point prevalence of maternal incarceration for mothers of children aged 0-17 years on 30 June 2003 was 60.9% Indigenous and 45.0% non-Indigenous women prisoners, p=0.0214, prevalence ratio (PR) 1.35, 95%CI 1.05 to 1.74. On 30 June 2011 67.5% Indigenous and 50.0% non-Indigenous women prisoners were mothers, p=0.0009, PR 1.31, 95%CI 1.13 to 1.61. As shown in Table 2, there were 3,827 mothers in total. Indigenous mothers (Mdn = 2) had higher numbers of children within the cohort than non-Indigenous mothers (Mdn = 2), U= -12.69, p<0.0001. Around three-quarters (72%) of non-Indigenous mothers had 1-2 children compared to half (53%) of Indigenous mothers, whereas, half (47%) of Indigenous mothers had 3-12 children compared with one-quarter (28%) of non-Indigenous mothers, χ^2 (4, N= 3827) = 213.90, p<0.0001. Data do not represent total family size as only children who met the study criteria are included.

Indigenous mothers (Mdn age = 25.4 years) were younger than non-Indigenous mothers (Mdn age = 28.9 years) at the time of their first imprisonment when their child entered the cohort, U= 14.007, p<0.0001. Indigenous mothers were three-times more likely to be aged less than 20 years, and four-times more likely to be under 18 years of age. Age profile of Indigenous and non-Indigenous mothers differed across age groups in Table 2, χ^2 (6, N= 3,827) = 200.27, p<0.0001.

The number of imprisonments per mother was lower for non-Indigenous mothers (Mdn = 1) than Indigenous mothers (Mdn = 2), U= -11.54, p<0.0001. Around half (54%) Indigenous mothers had 1-2 imprisonments compared to 70% of non-Indigenous mothers. While one-quarter (26%) of Indigenous mothers were imprisoned 5-42 times, compared to 12% of non-Indigenous mothers who were imprisoned 5-24 times, χ^2 (4, N= 3827) = 145.69, p<0.001.

In total, cohort mothers had 12,370 records of imprisonment while at least one of their children was aged 0-17 years. Indigenous mothers had shorter prison stays (Mdn = 15.8 days) than non-Indigenous mothers (Mdn = 20.8 days), U= 4.28, p<0.0001. Patterns of length of imprisonments in Table 2 were similar for Indigenous and non-Indigenous mothers, but differed across all categories, χ^2 (7, N= 12370) = 100.73, p=0.0001. Three-quarters (n=9,219) of all mothers' imprisonment records were for three-months or less.

Length of imprisonment may be influenced by offence type which differed between Indigenous and non-Indigenous mothers (Table 2), χ^2 (15, N= 11,782) =1.5e+3, p=0.0001. Indigenous mothers were twice as likely to be detained for acts intended to cause injury or endangerment offences than non-Indigenous mothers. Similar proportions of Indigenous and non-Indigenous mothers' records were for breach of justice procedures. Fraud offences were more common amongst non-Indigenous mothers, as were illicit-drug offences. Similar proportions of mothers were detained for unlawful entry with intent, theft and traffic offences. Homicide, sexual assault, abduction and weapons offences contributed to a small proportion of mothers' records. Sentence type differed between Indigenous and non-Indigenous mothers, χ^2 (1, N= 12370) = 48.03, p<0.0001.

Annual prevalence of children experiencing maternal incarceration in WA

Figure 1 displays the annual age-standardised rates of WA children experiencing maternal incarceration in WA across the study period. The number of children affected each year,

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prevalence figures and prevalence ratios with 95%CIs are detailed in Supplementary Table 1. Across 2003-2011 on average 1,544 WA children were affected by maternal incarceration each year, at a rate of 303 children per 100,000 population aged 0-17 years. As can be seen from the marked difference in scale between the two graphs in Figure 1, Indigenous children aged 0-17 years were 27 times (95%CI 24.5–30.3) more likely to experience maternal incarceration across 2003-2011 with an average rate of 2,929 per 100,000 Indigenous children (n=1,034) affected each year, compared to 108 per 100,000 non-Indigenous children (n=510). Between 2003-2011 the average annual percent change was -0.9% for Indigenous children, 1.8% for non-Indigenous children, and -0.3% overall for all children aged 0-17 years.

Childhood prevalence of maternal incarceration for children born in WA

Supplementary Table 2 outlines the age-specific childhood prevalence figures for WA children by year of birth. Nearly one-fifth (18.8%, n=1,368) of Indigenous children born in WA between 1992-1996 experienced maternal incarceration during childhood to age 17 years. In comparison, 0.7% (n=843) of non-Indigenous children born during the same period were affected. Accordingly, Indigenous children were 26 times (95%CI 23.9 to 28.2) more likely to be affected than their non-Indigenous counterparts. The average annual percent change for children born between 1992-1996 was -7.3% for Indigenous children, 1.1% for non-Indigenous children, with an overall increase of 2.2%.

Comparison between WA and NSW estimates for children aged 0-15 years in 2001

Analysis of data of children aged 0-15 years affected by maternal incarceration in WA in 2001 was undertaken for comparison with published estimates of children affected in NSW.[20] Similar rates of non-Indigenous

Table 2: Characteristics of children born in Western Australia (1985-2011) affected by maternal incarceration during childhood (0-17 years) and their mothers.

Characteristics	Indigenous n (%)	Non-Indigenous n (%)	Total n (%)
Children			
Number	5,943 (64)	3,409 (36)	9,352 (100)
Sex			
Male	3,021 (51)	1,772 (52)	4,793 (52)
Female	2,922 (49)	1,637 (48)	4,559 (48)
Age at first exposure***			
Birth	109 (2)	83 (2)	192 (2)
0-4 years	3,235 (54)	1,606 (47)	4,841 (52)
5-9 years	1,530 (26)	979 (29)	2,509 (27)
10-14 years	809 (14)	560 (16)	1,369 (15)
15-17 years	260 (4)	181 (5)	441 (5)
Socioeconomic level[a]***			
1 (least disadvantaged)	70 (1)	191 (6)	261 (2)
2	215 (4)	368 (11)	583 (6)
3	566 (10)	572 (17)	1,138 (12)
4	1,196 (20)	880 (26)	2,076 (22)
5 (most disadvantaged)	3,884 (65)	1,384 (41)	5,268 (56)
Imprisonments			
Number prison records	8,130 (66)	4,240 (34)	12,370 (100)
Records per mother***			
1	755 (36)	877 (50)	1,632 (43)
2	374 (18)	359 (20)	733 (19)
3	249 (12)	191 (11)	440 (12)
4	155 (7)	118 (7)	273 (7)
5+	542 (26)	207 (12)	749 (20)
Duration***			
< 24 hours	716 (9)	454 (11)	1,170 (9)
1-7 days	2,305 (28)	1,085 (26)	3,390 (27)
1-4 weeks	1,838 (23)	803 (19)	2,641 (21)
1-3 months	1,373 (17)	645 (15)	2,018 (16)
3-6 months	838 (10)	510 (12)	1,348 (11)
6-12 months	657 (8)	402 (9)	1,059 (9)
1-2 years	320 (4)	257 (6)	577 (5)
2+ years	83 (1)	84 (2)	167 (1)
Sentence type[c]***			
Unsentenced	3,254 (40)	1,972 (47)	5,226 (42)
Sentenced	4876 (60)	2,268 (53)	7,144 (58)

Characteristics	Indigenous n (%)	Non-Indigenous n (%)	Total n (%)
Mothers			
Number	2,075 (54)	1,752 (46)	3,827 (100)
Number of children	5,785 (62)	3,567 (38)	9,352 (100)
Children per mother***			
1	655 (32)	759 (43)	1,414 (37)
2	438 (21)	501 (29)	939 (25)
3	375 (18)	293 (17)	668 (17)
4	261 (13)	117 (7)	378 (10)
5+	346 (17)	82 (5)	428 (11)
Age at imprisonment[b]***			
13-17 years	107 (5)	25 (1)	132 (3)
18-19 years	233 (11)	76 (4)	309 (8)
20-24 years	669 (32)	430 (24)	1,099 (28)
25-29 years	489 (23)	448 (25)	937 (24)
30-34 years	328 (16)	375 (21	703 (18)
35-39 years	172 (8)	228 (13)	400 (10)
40+ years	69(3)	117 (7)	186 (5)
Imprisonments			
Offence type[d]***			
Homicide	68 (1)	31 (1)	99 (1)
Injury	1,830 (24)	419 (10)	2,249 (20)
Sexual assault	12 (<1)	21 (<1)	33 (<1)
Endangerment	423 (5)	76 (2)	499 (4)
Abduction	91 (1)	42 (1)	133 (1)
Robbery/extortion	305 (4)	212 (5)	517 (4)
Unlawful entry	921 (12)	512 (13)	1,433 (12)
Theft	867 (11)	524 (13)	1,391 (12)
Fraud	182 (2)	518 (13)	700 (6)
Illicit drug	87 (1)	452 (11)	539 (5)
Weapons	20 (<1)	11 (<1)	31 (<1)
Property damage	196 (3)	57 (1)	253 (2)
Public order	312 (4)	55 (1)	367 (3)
Traffic regulatory	852 (11)	461 (11)	1,313 (11)
Justice procedures	1,476 (19)	656 (16)	2,132 (18)
Miscellaneous	57 (1)	36 (1)	93 (1)

a: Missing socioeconomic data for 12 Indigenous and 14 non-Indigenous children.

b: Age of mother determined at imprisonment when first child entered the cohort during the study period.

c: 'Sentenced' imprisonments can include a period where the prisoner is held on remand (unsentenced) before they were sentenced.

d: Offence data missing for 431 Indigenous and 157 non-Indigenous records of imprisonment.

**** $p<0.0001$*

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children were affected in WA (108 per 100,000) and NSW (112 per 100,000) during 2001.[20] Twice the proportion of Indigenous children were affected in WA (2,738 per 100,000) than NSW (1,449 per 100,000).[20] Comparison of data for children aged 0-15 years in 2001 who had ever experienced the incarceration of their mother throughout childhood, found a 2.4-fold greater rate of Indigenous WA children affected (8,838 per 100,000) compared to NSW estimates (3,689 per 100,000).[20] However, the difference in rates was 1.8-fold higher for non-Indigenous children in NSW (599 per 100,000) than in WA (328 per 100,000).[20]

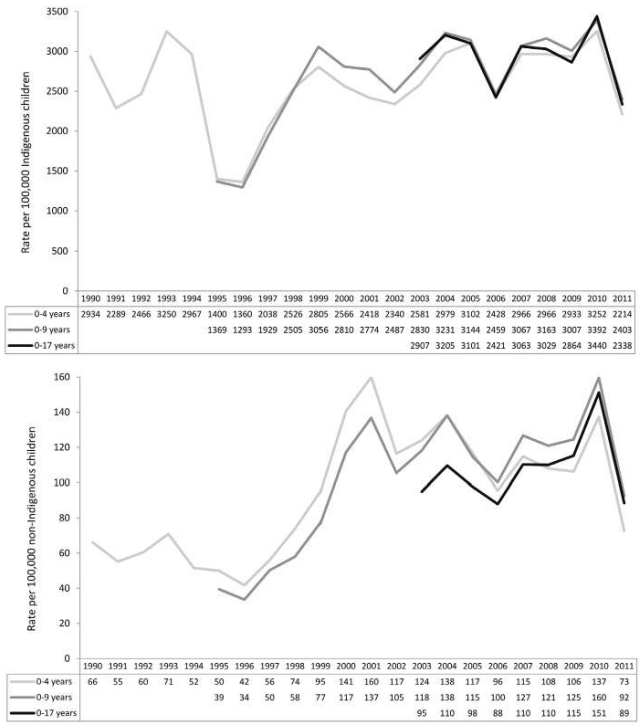
Discussion

Using whole-population linked data this article provides the first census of children affected by maternal incarceration in an Australian State. It demonstrates that Indigenous children and mothers are disproportionately affected. Across 2003-2011, WA Indigenous children aged 0-17 years were 27 times (95%CI 24.5 to 30.3) more likely to be affected than non-Indigenous children. This disparity reflects higher rates of imprisonment of Indigenous women[22] and their greater likelihood of being mothers at younger ages and with higher fertility rates.

Figure 1 illustrates annual prevalence across the study period. The drop in rate of Indigenous children affected between 1994 and 1996, seen to a lesser extent for non-Indigenous children, coincides with the enactment of the *Fines, Penalties and Infringement Notices Enforcement Act 1994* (WA).[39] The purpose of the Act was to reduce the use of imprisonment for non-payment of fines by providing alternative sentencing options such as licence suspension and property forfeiture.[40] Regarding the subsequent rise in rates seen from 1997, it has been postulated that the policy was not as effective at reducing imprisonment for low socioeconomic status women.[41,42]

For children born between 1992 and 1996 there was a -7.3% decline in prevalence of Indigenous children who experienced maternal incarceration by age 17-years, compared to a 1.1% increase for non-Indigenous children. The denominator (number of WA births) is likely responsible for this apparent trend. Supplementary Table 2 reports the number of children born each year who were affected by maternal incarceration throughout childhood. The number of children affected between birth

Figure 1: Age-standardised rates of Indigenous and non-Indigenous children affected by maternal incarceration each year, 1990-2011.



years fluctuates within a relatively small range for both Indigenous and non-Indigenous children. However, from 1992 to 1996 the total number of Indigenous births increased (n=1,215 to n=1,538), while non-Indigenous births decreased (n=23,858 to n=23,255).[32]

The higher rates of Indigenous children affected in WA annually and throughout childhood compared to NSW[20] is likely largely explained by higher rates of Indigenous female imprisonment in WA (560 per 100,000 women) than NSW (391 per 100,000 women) in 2001.[22] This may in part reflect differences in offences, penalties and sentences imposed between the States. For example, a fine is the most common penalty for traffic related offences in WA (for which non-payment may result in imprisonment) whereas in addition to fines NSW imposes alternative penalties including 'intensive supervision' and 'no conviction recorded'.[43]

Since our final study estimates in 2011 the rate of female imprisonment in WA has increased by 18%, with the number of Indigenous women prisoners rising by 37% compared to 10% for non-Indigenous women prisoners.[22] Accordingly, the disparity reported here between Indigenous and non-Indigenous children and mothers has likely only been exacerbated.

Note that the increasing rate of Indigenous female imprisonment is not necessarily associated with an equal increase in offending behaviours or criminality within the community. Analysis has found the predominant cause of increasing Indigenous imprisonment within NSW is a more rigid response to Indigenous offenders throughout the criminal justice system, such as in remand and sentencing practices.[44] This can be driven by socioeconomic factors such as homelessness, for example bail is often contingent on having stable accommodation which can result in offenders being detained on remand in instances where they would otherwise be released before trial.[45] As shown in this study, Indigenous children were most likely to reside in the lowest 20%

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of socioeconomic areas, indicating the high level of disadvantage also experienced by their mothers.

The cohort generally experienced higher levels of socioeconomic disadvantage than the wider WA population. For Indigenous cohort children, 65% resided in the lowest socioeconomic quintile compared to 46% of the WA Indigenous population and 1% in the highest quintile compared to 6% of the WA Indigenous population.[46] The difference was more pronounced for non-Indigenous cohort children, with 41% in the lowest quintile compared to 11% of the WA non-Indigenous population and 6% in the highest quintile compared to 28% of the WA non-Indigenous population.[46]

Children are most likely to first experience maternal incarceration when aged less than five-years. This is a key time in child development. The attachment literature illustrates how maternal separation during this time can result in lasting impacts on children.[47] Specialised mother-baby programs facilitated within prisons have improved attachment outcomes for infants at-risk of disorganised attachment relationships.[12] The majority of WA women prisoners report that their children are cared for by family members while they are incarcerated.[2] Qualitative research has found children still experience significant disruption to their living and care arrangements during this time.[3,48] Further research is required to understand children's outcomes and their relationship to the experience of maternal incarceration.

Internationally, cumulative risk of maternal imprisonment in childhood up to 14 years of age has been estimated in Denmark and the United States (US) using a single-year birth cohort of all children born in 1990 using administrative registry data in Denmark and a number of sources of prisoner data in the US. Denmark estimates included prison stays less than 24 hours, as was our approach.[49] In Denmark, 2.2% of children born in 1990 experienced maternal incarceration by age 14-years.[49] In comparison, 1.6% of WA children born in 1990 experienced maternal incarceration by age 17 years. However, significant increases in the WA female prison population occurred throughout the mid-1990s[22] with a corresponding increase in the number of children affected as demonstrated in this article.

The US data was restricted to prison stays of over one year,[49] making comparisons with the current study difficult. One comparison that can be made is the level of racial disparity observed. In the US 0.6% of White and 3.3% of Black children born in 1990 were affected by maternal incarceration (of one-year or longer) by 14 years of age, a 5.5-fold difference.[49] For WA children born in 1992, 0.7% of non-Indigenous and 23.7% of Indigenous children were affected by any maternal incarceration by age 18 years of age, representing a 35-fold difference. This reinforces the magnitude of the disparity in Australia.

Limitations

Estimates of Indigenous populations based on Australian census data and administrative data are affected by a number of factors.[29] Willingness to self-identify as Indigenous is often dependent on the context of the service contact.[29] This affects the accuracy of Indigenous population estimates and is more relevant for earlier study years. Best available data has been used in the identification of Indigenous status for study participants through the WADLS best-practice algorithm[29] and in using the most recently available data for population denominators.

Motherhood was defined according to formal Birth Registration data, therefore any non-biological mothers were excluded. Similarly excluded were children who migrated to WA after birth, or children born in WA whose mothers were imprisoned outside WA. Likewise biological mothers were assumed to have a continuing relationship with their children from birth. The WA DCS conducted interviews with 64 female prisoners in 2008, including questions on motherhood.[2] They found 61% of respondents had children under 18 years of age,[2] which was the figure we derived for 30 June 2008, thereby providing some support for the study estimates.

The quality of linked administrative data can be affected by factors such as incorrect or missing links and completeness.[50] The WA Data Linkage Branch implements a number of processes to enhance data validity.[50]

SEIFA IRSD data was only available for the 1996, 2001 and 2006 censuses.[34] The CD level score for the census closest to an individual's record was used. Economic and social characteristics of an area can change over time, which may affect SEIFA accuracy for the eldest cohort members born from 1985.

Conclusion

Using population-wide linked administrative datasets, this article provides accurate, high quality data on the size of the population of children and mothers affected by maternal incarceration in WA over two decades. It highlights the overrepresentation of Indigenous mothers and children within this population. Indigenous children experience maternal incarceration at higher rates, at younger ages and more frequently throughout childhood.

This study is timely in extending knowledge of the children affected by maternal incarceration as the WA DCS has recently formed the Women's Estate Reference Committee to advise on policy to address the needs of the State's increasing women's prison population.[51] This presents an opportunity to develop criminal justice policies that help to prevent further entrenchment of disadvantage for vulnerable families.

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Material presented cannot be considered as either endorsed by the Department of Corrective Services or an expression of the policies or view of the Department, and any errors or omission or commission are the responsibility of the Researchers.

Responsibility for interpretation of the data supplied through the Government of Western Australia, the Developmental Pathways in Western Australian Children Project, and by any other data custodian, is the Researchers' alone.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Table 1: Annual prevalence of maternal incarceration in Western Australia.

Supplementary Table 2: Childhood prevalence of maternal incarceration in Western Australia.

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RESEARCH ARTICLE Open Access

Maternal incarceration, child protection, and infant mortality: a descriptive study of infant children of women prisoners in Western Australia

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Abstract

Background: There are no population statistics collected on a routine basis on the children of prisoners in Australia. Accordingly, their potential vulnerability to adverse outcomes remains unclear. This study draws on linked administrative data to describe the exposure of children aged less than 2 years to maternal imprisonment in Western Australia, their contact with child protection services, and infant mortality rates.

Results: In Western Australia, 36.5 per 1000 Indigenous ($n = 804$) and 1.3 per 1000 non-Indigenous ($n = 395$) children born between 2001 and 2011 had mothers imprisoned after birth to age 2 years. One-third of infants' mothers had multiple imprisonments (maximum of 11). Nearly half (46%) of prison stays were for ≤2 weeks, 12% were between 2 and 4 weeks, 14% were for 1–3 months, and 28% were longer than three months. Additionally, 17.4 per 1000 Indigenous ($n = 383$) and 0.5 per 1000 non-Indigenous ($n = 150$) children had mothers imprisoned during pregnancy. Half of the children with a history of maternal incarceration in pregnancy to age 2 years came into contact with child protection services by their second birthday, with 31% of Indigenous and 35% of non-Indigenous children entering out-of-home care. Rates of placement in care were significantly higher for Indigenous children (Relative Risk (RR) 27.30; 95%CI 19.19 to 38.84; $p < .001$) and for non-Indigenous children (RR 110.10; 95%CI 61.70 to 196.49; $p < .001$) with a history of maternal imprisonment compared to children of mothers with no corrections record. Infant mortality for children whose mothers were imprisoned up to 5 years before birth or within their first year after birth was higher than for children of mothers with no corrections record for both Indigenous (RR 2.36; 95%CI 1.41 to 3.95; $p = .001$) and non-Indigenous children (RR 2.28; 95%CI 0.75 to 6.97; $p = .147$).

Conclusions: This study highlights the particular vulnerability of children whose mothers have been incarcerated and the importance of considering their needs within corrective services policies and procedures. Prison may present an opportunity to identify and work with vulnerable families to help improve outcomes for children as well as mothers.

Keywords: Women, Children, Prisoners, Infant mortality, Child protection, Vulnerable populations

Background

Children of prisoners are highly vulnerable. Prisoners experience elevated rates of adversity including mental illness, domestic violence, substance use disorders, poverty, homelessness, racism and discrimination (Abbott, Magin, & Hu, 2016; Department of Corrective Services, 2009; Friestad, Ase-Bente, & Kjelsberg, 2012). These adverse experiences within a family environment are known to increase the risk of poor outcomes for children, particularly in the early years of infancy (Brown, Anda, Tiemeier, Felitti, Edwards, Croft, & Giles, 2009). Studies have found children with incarcerated parents experience a range of issues such as poor developmental outcomes, behavioural problems, educational difficulties, and increased mortality (Aaron, & Dallaire, 2010; Byrne, Goshin, & Joestl, 2010; Dallaire, Zeman, & Thrash, 2015; Rud, Van Klaveren, Groot, &

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Maassen van den Brink, 2014; Wildeman, Andersen, Lee, & Karlson, 2014). Much of the literature on children of prisoners has been conducted within the United States, United Kingdom and Europe (Murray, Bijleveld, Farrington, & Loeber, 2014). There is comparatively less known about the experience of children in other countries, including Australia. There is also relatively little evidence available on children of prisoners at a population level.

Within Australia, and beyond, there is no routine reporting of the prevalence of children affected by parental incarceration, nor their health or welfare (Dennison, Stewart, & Freiberg, 2013). Infant mortality is the most significant adverse outcome that can be experienced and is a strong marker of disadvantage and represents a measure of the health of a population (Reidpath, & Allotey, 2003). There is a lack of information on infant mortality outcomes for women prisoners, as distinct from imprisoned fathers, due to their relatively smaller numbers (Wildeman, 2012).

Child protection system contact is also an important measure of child welfare. Children with a history of placement in out-of-home care are at increased risk for a range of ongoing difficulties including mental illness, behavioural problems and poor school performance (Maclean, Taylor, & O'Donnell, 2016; Osborn, Delfabbro, & Barber, 2008). In addition, information on the characteristics of children's exposure to parental incarceration is not readily available. There is no reporting on such characteristics as the duration and frequency of parental prison stays, or on the classification of parental offences. This information is important for establishing the health status and service needs of children of prisoners, and to inform future research priorities.

In the absence of formal population surveillance, data linkage provides a means for accurately describing the prevalence and characteristics of children of prisoners. Data linkage connects information relating to individuals within defined populations across multiple collections of data which are routinely recorded by government services and departments for primarily administrative purposes, such as hospital admission data or records of births, deaths and marriages (Holman, Bass, Rouse, & Hobbs, 1999). Data linkage can provide retrospective coverage of entire populations of interest, while maintaining the confidentiality of individuals, making it highly suitable for investigating marginalised groups such as the prisoner population, and rare outcomes such as infant mortality.

This study draws on linked data to provide key descriptive statistics for the population of infant children of women prisoners in Western Australia. Infants are a priority population given their vulnerability and unique developmental considerations. Infants have an absolute reliance on caregivers for their basic needs, lack communication skills, and have less structured contact with community services, such as schooling, where at-risk individuals may be identified. Experiences of adversity during pregnancy and infancy have significant and long-term consequences for child health and development. Exposure of the fetus during pregnancy or of the infant after birth to factors such as poor nutrition and maternal alcohol and drug abuse, domestic violence, and maternal stress has been shown to result in poor health outcomes including low birth weight, infant mortality and developmental delay (McMillen & Robinson 2005; Heindel, & Vandenberg, 2016; Latendresse et al., 2015). Women prisoners have increased risk of poor pregnancy outcomes including low birth weight infants when compared to women in the general community, as well an increased risk of disrupted attachment with their infants (Knight, & Plugge, 2005; Poehlmann, 2005). Despite their vulnerability, it is not known with any certainty how many Australian children experience the imprisonment of their mother in pregnancy or infancy, or the degree to which infants with a history of maternal imprisonment experience higher rates of mortality or child protection contact than infants in the general community.

There are also limited data on the infant children of Australian Indigenous women prisoners, despite their overrepresentation in the prison population. In Western Australia, for example, Indigenous peoples represent 4% of the general population but 46% of the female prison population (Australian Bureau of Statistics (ABS), 2016; ABS, 2011). Indigenous children are also overrepresented in the Australian child protection system. Similarly, Indigenous peoples in Australia experience poorer pregnancy outcomes compared with non-Indigenous mothers, and while infant mortality rates have improved across time for both Indigenous and non-Indigenous populations, a racial disparity remains (Council of Australian Governments (COAG) 2016). This reflects the high levels of disadvantage and discrimination experienced by Indigenous peoples in Australia stemming from the historical and continuing impacts of colonisation, such as land dispossession, racism, and the forced removal of children from their families (COAG, 2009).

Accordingly this study will provide a description of the population of infant children of Western Australian women prisoners including details of the characteristics of exposure of infant children (aged less than 2 years) to maternal imprisonment, as well as measuring child protection system contact and infant mortality rates for the population.

Methods

Aims

This study draws on whole-population linked administrative data to examine maternal incarceration exposure, child protection system contact, and mortality rates for infant children of Western Australian women prisoners.

Aim 1: To describe the features of maternal incarceration exposure including the proportion of women prisoners who are pregnant; the prevalence of children exposed to maternal incarceration between birth and

before age-2; and offence type and length and frequency of maternal imprisonments for children between birth and before age-2.

Aim 2: To describe contact with the child protection system before 2 years of age for children whose mothers have a record of imprisonment during pregnancy or before the child's second birthday and for children whose mothers have no corrections record.

Aim 3: To determine infant mortality rates for children of women with a history of imprisonment 5 years before birth or within their first year after birth and for children whose mother had no contact with corrective services.

Data sources

Data were obtained through the Western Australian Data Linkage System (WADLS). The WADLS uses highly accurate computerised probabilistic matching with clerical review to create linkages between administrative data collections across a range of Western Australian government departments and services (Holman et al., 1999). For the present study, records were extracted from the Midwives Notifications System, Birth Registrations, Death Registrations, Department of Justice, and Department of Communities: Child Protection and Family Support data collections. These are all State-wide and statutory data collections with good coverage of the Western Australian population.

The Birth Registration and Midwives Notifications System data provides social and demographic characteristics of mothers and children at time of birth. Death data includes all deaths registered in Western Australia. The Department of Justice data collections include all custodial records for offenders held in Western Australian prisoners or under supervision of the Department on community-based correctional orders. The Department of Communities: Child Protection and Family Support data includes all reports of concerns for child welfare made to the child protection system and the details of investigations, protection applications and orders as well as placements in out-of-home care.

Study population

The study population was drawn from a retrospective longitudinal cohort study of all children born in Western Australia between 1985 and 2011 whose biological mother was imprisoned at least once between their date of birth and 18th-birthday, identified using the Midwives Notification System and Registry of Births in conjunction with linked Department of Justice prison data. For a description of the full cohort see Dowell, Preen, and Segal (2017). The cohort study included a randomly sampled comparison group of children whose mother had no record of imprisonment from their birth to their 18th-birthday, which was identified through the same data sources as the cohort and matched 3:1 to cohort children on Indigenous status, age and gender.

The present study focused on a subset of children within the full cohort born from 2001 onwards. This time period was chosen due to substantial changes in the annual prevalence of children affected by maternal incarceration in Western Australia in the 1990s (Dowell et al., 2017). To address the three study aims, we have conducted three separate analyses all of which have slightly different observation periods, and hence different study populations, as summarised in Table 1. All analyses were stratified by Indigenous status given differences between Australian Indigenous and non-Indigenous populations in terms of their demographic characteristics, health status, sentence type and unique cultural contexts.

To address aim 1, maternal incarceration exposure was described for pregnancy and after birth to before age 2-years separately, because of the different implications of imprisonment for unborn and infant children. The study population included children born 2001–2011 whose mother was imprisoned in pregnancy between 2000 and 2011 (n = 533) and children whose mother was imprisoned from birth to before age-2 between 2001 and

Table 1 Observation periods for key analyses

Aim/Analyses	Maternal imprisonment observation period	Child birth years	Data observation years	Prison group n	Comparison group n
1. Maternal incarceration exposure					
In pregnancy	Pregnancy	2001–2011	2000–2011	533	–
In infancy	Birth to age < 2	2001–2011	2001–2013	1199	–
2. Child protection system contact					
All children	Pregnancy to age < 2	2001–2011	2000–2017	1383	6714
3. Infant mortality rates					
All children	5-years pre-birth to age < 1	2001–2011	1996–2012	2180	6714
Indigenous children (Fig. 2)	5-years pre-birth to age < 1	1992–2011	1987–2012	2818	7190

2013 (n = 1199). There were 349 children within both groups who were exposed to maternal imprisonment in pregnancy and after birth before age-2. Mothers could have multiple children who met the inclusion criteria.

To address aim 2, child protection system contact was described from the start of pregnancy through to before age-2, as it is possible for child protection notifications to be raised for unborn children in Western Australia.

To address aim 3, we studied children born to mothers with a history of imprisonment 5-years before birth to age-1 (n = 2180) as infant mortality is a rare outcome in Australia and there were not sufficient numbers of infant deaths to limit analyses to children of mothers imprisoned in pregnancy and their first year. Accordingly, the analyses explore the population characteristics and mortality outcomes of children whose mothers have a history of imprisonment. Not all children in our defined at-risk group will be directly exposed to maternal imprisonment in utero or after birth. Infant mortality rates for Indigenous children born from 1992 onwards were calculated in order to illustrate the change in rates over time. A similar calculation was not possible for non-Indigenous children, due to small numbers. Western Australian birth data for population denominators are only available by Indigenous status from 1992 onwards (ABS, 2015).

The comparison groups were also stratified by Indigenous status and limited to children whose mothers never had a record in any Department of Justice data collection (including for community-based correctional orders) at any time during the period from 1985 to 2014. These groups were selected to describe the difference in child protection system contact and infant mortality between infants of women prisoners and infants within a general community sample with no maternal corrections history.

Analyses

Maternal incarceration exposure

The proportion of women prisoners who are pregnant was calculated from the total number of Western Australian women prisoners using Australian Prisoner Census data (ABS, 2016). As the Prisoner Census records the prison population on a single day (30 June) each year, the numbers of pregnant women in custody on 30 June annually were identified from the study data using mothers' prison reception and discharge dates and children's birthdates. Pregnancy start date was calculated as being nine months before child birth-month, as child birthdate was provided to month of birth only and gestational age was not available.

The prevalence of children whose mother was imprisoned during their infancy (birth to age 2-years) was calculated for Indigenous and non-Indigenous children born in Western Australia across the period of 2001 to 2011 using population birth data from the ABS (ABS, 2015). The number, length and nature of offence for maternal imprisonments during infancy, were described using child birth and death dates, mother prison reception and discharge dates, sentence type, and major offence type using the Australian and New Zealand Standard Offence Classification (Pink, 2011). Maternal imprisonments included both juvenile and adult sentenced offenders and remandees held in Western Australian prisons.

Child protection system contact

Child protection system contact was defined as any record within the Western Australian Department of Communities: Child Protection and Family Support database for reports made to the Department concerning a child's welfare, applications or orders for a child's protection, and periods of out-of-home care (including for respite care as well as child maltreatment).

The proportion and rate (per 1000) of children who had any child protection contact (including out-of-home care) was calculated for children whose mother had a record of imprisonment during pregnancy and/or from birth to age 2-years, and for those whose mother never had a corrections record. The proportion and rate of children who were placed in out-of-home care was also calculated.

Infant mortality

Infant mortality rate is commonly defined as "the number of deaths under one year of age occurring among the live births in a given geographical area during a given year, per 1000 live births occurring among the population of the given geographical area during the same year" (Organisation for Economic Co-operation and Development (OECD) 2006). All children within the study population were live-born. Infant mortality rates (per 1000) across the period 2001–2011 were calculated for children with a history of maternal imprisonment and children of mothers with no corrective services history stratified by Indigenous status.

Infant mortality rates were calculated for Indigenous children born from 1992 to 2011 using 6-year moving averages (e.g. 1992–1997, 1993–1998, etc.) and presented for children of mothers with an incarceration history, children of mothers with no history of corrective services contact, and for all Western Australian Indigenous children, the latter using ABS data.

Indigenous status

Indigenous status for children and mothers in the study populations was provided through the Derived Indigenous Status Flag variable generated by the WADLS using best-practice algorithms, which assess individuals' Indigenous

status across multiple data collections to enhance accuracy (Christensen et al., 2014).

Offence type

Major offence type is recorded in the Department of Justice data collections using the Australian and New Zealand Standard Offence Classification, which contains 16 Divisions classified according to the offence aim, use of violence, victim, seriousness and intent (Pink, 2011). For the present study, offence type were described in six categories: Offences against the person (Divisions 1–5); Theft and related (Divisions 6–8); Fraud and related (Division 9 and bribery offences); Drug (Division 10 and licit drug offences); Public order (Divisions 11–13 and 16); Traffic and related (Division 14, and driving under the influence of alcohol or other substance, dangerous or negligent driving offences); and Breach of justice procedures (Division 15).

Socioeconomic status and geographical remoteness

The Socio-economic Indexes for Areas Index of Relative Socio-economic Disadvantage (ABS, 2013) and the Accessibility/Remoteness Index of Australia (ABS, 2014) were used to describe infant's socioeconomic status and geographical remoteness of their place of residence at time of birth.

Statistical analysis

All statistical analyses were performed in Stata version 14.0 and stratified by Indigenous status. The analyses were undertaken to establish whether the study populations differed in terms of their key characteristics. Pearson's chi-square was used to assess the difference between study sub-populations' basic demographic characteristics including sex, socioeconomic status, and geographical remoteness. A log-binomial regression model was applied to the child protection and infant mortality data to obtain risk ratios for comparing children of women prisoners with children whose mothers had no corrections record (Knol, Le Cessie, Algra, Vandenbroucke, & Groenwold, 2011; McNutt, Wu, Xue, & Hafner, 2003; Robbins, Chao, & Fonseca, 2002).

Results

Descriptive characteristics of the study sub-populations

Table 2 describes the basic demographic characteristics of the study populations. Within the Indigenous and non-Indigenous populations, there were no statistically significant differences ($p > .05$) between the two maternal imprisonment history subgroups across all characteristics. Likewise, within each of the Indigenous and non-Indigenous populations, there were no significant differences with respect to the sex distributions of the groups of infants with maternal imprisonment histories to those with no maternal corrections

Table 2 Descriptive characteristics of the study sub-populations, by Indigenous status

	Indigenous			Non-Indigenous		
	Maternal imprisonment		No maternal corrections	Maternal imprisonment		No maternal corrections
	Pregnancy to <2 yrs	5 yrs. before birth- < 1 yr		Pregnancy to <2 yrs	5 yrs. before birth- < 1 yr	
	%	%	%	%	%	%
Sex						
Male	50.2	50.4	52.4	50.8	51.3	48.0
Female	49.8	49.6	47.6	49.2	48.7	52.0
Socioeconomic status						
Most disadvantage, 0–20%	58.7	58.5	60.0	42.0	42.9	20.5
21–40%	21.7	22.4	21.3	22.7	21.3	23.2
41–60%	11.8	11.8	8.9	18.1	16.5	16.3
61–80%	4.6	4.7	7.0	9.6	11.6	22.6
Least disadvantage, 81–100%	3.2	2.6	2.8	7.6	7.7	17.3
Geographical remoteness						
Major cities	59.1	59.1	32.2	81.9	81.5	70.6
Inner regional	4.5	5.5	7.4	11.5	11.2	12.3
Outer regional	13.4	15.3	16.9	5.3	5.7	10.1
Remote[a]	11.0	9.6	20.4	1.4	1.6	7.0
Very remote[a]	12.0	10.5	23.2			
Infants (n)	944	1283	2923	439	511	3791

Notes
[a]'Remote' and 'Very remote' categories combined for non-Indigenous due to cell counts of $n < 5$

record. In both the Indigenous and non-Indigenous populations, infants with a history of maternal imprisonment had different distributions of socioeconomic status and geographical remoteness in comparison to infants with no maternal corrections history.

Maternal incarceration exposure

Pregnancy

Between 2001 and 2011, 5.7% of Indigenous and 4.0% of non-Indigenous Western Australian female prisoners were pregnant while imprisoned. Over the same period 383 Indigenous (17.40 per 1000) and 150 non-Indigenous (0.49 per 1000) children were born to mothers who were imprisoned at least once while pregnant with them.

Birth to two-years

Table 3 provides a summary of children's exposure to maternal incarceration in infancy. In total, 804 Indigenous and 395 non-Indigenous children had a mother imprisoned at least once between their birth and their second birthday, equating to 36.52 per 1000 Indigenous and 1.29 per 1000 non-Indigenous children born in Western Australia between 2001 and 2011. Of these children, 30% of Indigenous and 27% of non-Indigenous, also had their mother imprisoned while pregnant with them.

For most children exposed to maternal incarceration between birth and age 2-years, their mothers were imprisoned just once (63% Indigenous and 75% non-Indigenous children). The mean (SD) length of incarceration was 97 (184) days but the distribution was highly skewed, with half of all mothers' prison stays being for periods less than three-weeks with a median (IQR) of 19 (4–110) days.

The level of exposure varied considerably across the population of children exposed to maternal incarceration with 37% of Indigenous and 25% of non-Indigenous children experiencing multiple (up to 11) periods of maternal incarceration during infancy. For 22% of Indigenous and 23% of non-Indigenous children, their mother was imprisoned in total for more than a quarter of their life to age 2-years.

As shown in Table 3, mothers of children aged less than 2-years are more frequently imprisoned for non-violent offences related to theft, breach of justice procedures, and traffic offences. Offences against a person (e.g., acts intended to cause injury) accounted for 29% of Indigenous and 17% of non-Indigenous mothers' imprisonments.

Child protection system contact

As shown in the Table 4, a considerably higher proportion of children had contact with the Western Australian child protection system by their second birthday if their mother was imprisoned during pregnancy or infancy, compared with children whose mother never had any involvement with corrective services.

For children born between 2001 and 2011 with a history of maternal imprisonment in pregnancy or infancy, 537 (568.9 per 1000) Indigenous and 243 (553.5 per 1000) non-Indigenous children came into contact with the child protection system by their second birthday. Of those children, 291 (31%) Indigenous and 153 (35%) non-Indigenous children were removed and placed in out of home care by age 2.

In comparison to children whose mothers had no corrections involvement, children of mothers with a prison record in pregnancy or infancy were 8-times (RR 7.99; 95%CI 6.93 to 9.22, $p < .001$) and 28-times (RR 28.36; 95%CI 22.29 to 36.08, $p < .001$) more likely to have contact with the child protection system by age 2 years for Indigenous and non-Indigenous children respectively. Rates of placement in out-of-home care by age-2 were 27-times (RR 27.30; 95%CI 19.19 to 38.84, $p < .001$) greater for Indigenous and 110-times (RR 110.10; 95%CI 61.70 to 196.49, $p < .001$) greater for non-Indigenous children whose mothers had a prison history during pregnancy to age 2-years compared to children whose mothers had no contact with corrections.

For the children of mothers with a record of imprisonment in pregnancy or infancy who had no child protection contact by age 2-years, a further 23% Indigenous and 19% non-Indigenous had child protection contact after their second birthday. A further 8% of Indigenous and 7% of non-Indigenous children had spent time in out-of-home care. This compared with 18% Indigenous (2% out-of-home care) and 4% non-Indigenous (0.5% out-of-home care) for children of mothers with no record of corrections contact.

By the end of the observation period in 2017, 21% of Indigenous and 26% non-Indigenous children with maternal imprisonment history in pregnancy or infancy had no child protection contact. This compares with 75% of Indigenous and 94% of non-Indigenous children of mothers with no corrections involvement.

Infant mortality

Across 2001–2011, Western Australian children whose mothers had a history of imprisonment prior to their birth (up to five years prior) or within their first year of life had an infant mortality rate of 22.6 deaths per 1000 Indigenous births and 7.8 deaths per 1000 non-Indigenous births. Infant mortality rates were higher for children of women prisoners compared to children of mothers who had no contact with corrective services by 2.36-times (95%CI 1.41 to 3.95, $p = .001$) for Indigenous and 2.28-times (95%CI 0.75 to 6.97, $p = .147$) for non-Indigenous children.

Table 3 Maternal incarceration exposure in infancy (birth to age 2-years) for Western Australian children born 2001–2011

	Indigenous		Non-Indigenous	
Characteristics	n	%	n	%
Child experience of maternal incarceration				
Mother imprisoned in infancy (not pregnancy)	561	69.8	289	73.2
Mother imprisoned in infancy and pregnancy	243	30.2	106	26.8
Number of maternal imprisonments in infancy, per child				
1	509	63.3	297	75.2
2	170	21.1	65	16.5
3	66	8.2	20	5.1
4+	59	7.3	13	3.3
Percentage of child's infancy mother was imprisoned				
0–5%	428	53.2	202	51.1
6–25%	203	25.2	104	26.3
26–50%	114	14.2	70	17.7
51–75%	47	5.8	14	3.5
76–100%	12	1.5	5	1.3
Length of maternal prison stays[a]				
Up to 2 weeks / 0–14 days	620	46.7	234	43.0
2–4 weeks / 15–30 days	154	11.6	63	11.6
1–3 months / 31–90 days	186	14.0	80	14.7
3–6 months / 91–180 days	138	10.4	61	11.2
6–12 months / 181–365 days	147	11.1	68	12.5
Greater than 1 year / 366+ days	82	6.2	38	7.0
Sentence type[a]				
Unsentenced – remand	683	51.5	265	48.7
Sentenced – default of fine	250	18.8	91	16.7
Sentenced – other	394	29.7	188	34.6
Offence type[ab]				
Against the person	361	29.3	87	16.6
Theft and related	389	31.6	162	30.9
Fraud and related	39	3.2	59	11.3
Drug offences	12	1.0	45	8.6
Public order	45	3.7	12	2.3
Traffic and related	173	14.0	59	11.3
Breach of justice procedures	213	17.3	100	19.1

[a]1871 maternal prison records in infancy (1327 Indigenous and 544 non-Indigenous)
[b]115 prison records missing offence type (95 Indigenous and 20 non-Indigenous)

Figure 1 shows the temporal change and difference in infant mortality rates between Indigenous children whose mother had a history of imprisonment and those whose mother had no corrections record, as well as the Western Australian average for Indigenous children. Between 1992 and 97 and 2006–11, infant mortality rates for Western Australian Indigenous children reduced by 56% overall and by 40% for children with maternal prison history, while there was less change in rates for children with no maternal corrections history with a 25% reduction over the period.

Discussion

A major finding of the study is that 1 in 3 children whose mothers were imprisoned during pregnancy or their first two years of life, were placed in out-of-home care by their second birthday. In contrast only 1 in 100 Indigenous and 1 in 300 non-Indigenous children whose

Table 4 Child protection system contact before and after age 2 years, by maternal imprisonment history

	Indigenous children				Non-Indigenous children			
	Maternal imprisonment		No corrections record		Maternal imprisonment		No corrections record	
Child protection contact	n	%	n	%	n	%	n	%
Child protection contact by age-2	537	56.9	208	7.1	243	55.4	74	2.0
Out-of-home care by age-2	*291*	*30.8*	*33*	*1.1*	*153*	*34.9*	*12*	*0.3*
No child protection contact by age-2	407	43.1	2715	92.9	196	44.6	3717	98.0
Child protection contact age-2+	*213*	*22.6*	*527*	*18.0*	*84*	*19.1*	*145*	*3.8*
Out-of-home care age-2+	*78*	*8.3*	*67*	*2.3*	*30*	*6.8*	*20*	*0.5*
Total	944	100	2923	100	439	100	3791	100

mothers had never been in contact with corrective services were placed in out of home care by the same age. While parental imprisonment has been recognised as a factor that contributes to infants and children being placed in care (Delfabbro, Borgas, Rogers, Jeffrey, & Wilson, 2009), the extent to which the population of women prisoners have children placed in care has not been previously quantified in Australia.

In our study, half of all imprisonments were for unsentenced mothers being held in custody on remand. In such circumstances it is possible mothers may not have time to arrange care for their children following their arrest (Healy, Foley, & Walsh, 2001; Dallaire, 2007). Nearly half of all imprisonments of mothers whose children were aged less than 2 years were for two-weeks or less. This raises the question of if and how the length of a mother's prison stay impacts on the likelihood of child protection contact. Prisoners held on remand or for short periods would be difficult to capture in prospective research and so have not featured much in prior studies.

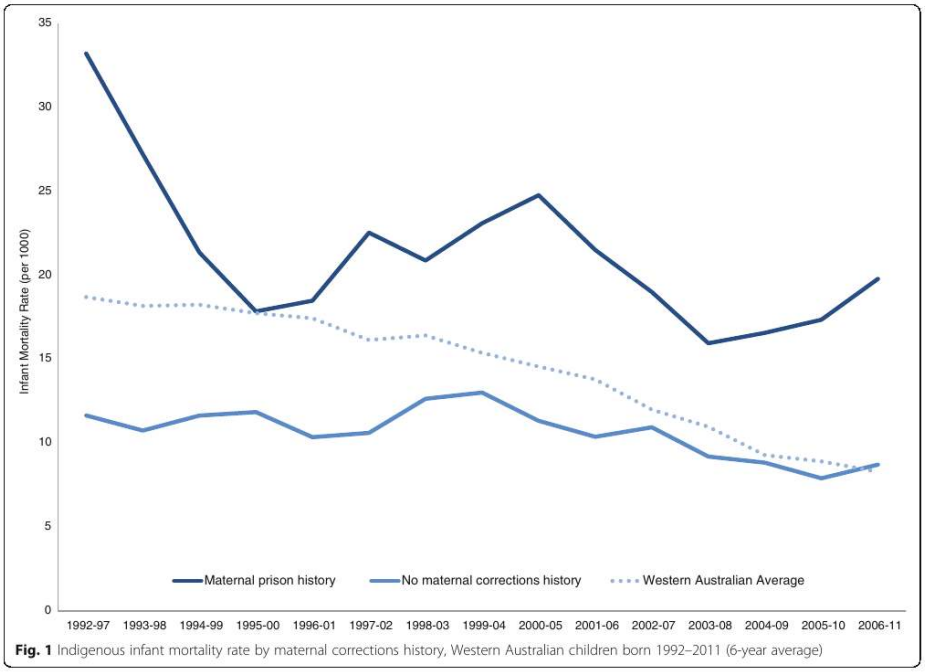


Fig. 1 Indigenous infant mortality rate by maternal corrections history, Western Australian children born 1992–2011 (6-year average)

The assumption is often that longer periods of imprisonment are potentially more harmful for young children, as in theory they are more likely to lead to disrupted attachment. But it is possible that shorter imprisonments, and unplanned detention in the case of remandees, create a greater disruption for already vulnerable families. Questions have been raised about the utility of short-term imprisonment in general (Trevena, & Weatherburn, 2015; Wermink, Blokland, Nieuwbeerta, Nagin, & Tollenaar, 2010). The data reported in this study highlight the importance of considering the value of very short-term maternal imprisonments. Such periods are unlikely to allow for any participation in rehabilitative programs and may increase the likelihood of children coming into contact with the child protection system, although whether such contact is helpful or harmful to the child is not known.

One in six of the maternal imprisonments in the cohort were for non-payment of fines. While nearly a third of maternal imprisonments for the Indigenous population were for violent offences against the person, a significant number of imprisonments for both Indigenous and non-Indigenous mothers were for non-violent crimes and fine default. There was legislative action taken to reduce imprisonments for non-payment of fines in Western Australia in the mid-1990s with the enactment of the *Fines, Penalties and Infringement Notices Enforcement Act* 1994 (WA). This appeared to lead to a significant reduction in maternal imprisonments from 1994 to 1996 (Dowell et al. 2017), although the current study demonstrates that default of fine remains a common reason for imprisonment of Western Australian women prisoners with young children. The Western Australian legislation has since been described as having "a discriminatory and disproportionate effect, leading to the over-representation of Aboriginal and Torres Strait Islander peoples, poor people and vulnerable people, in the Western Australian prison system" (Law Society of Western Australia, 2016). Female prisoners are more frequently imprisoned for default of fine than male prisoners in Western Australia (Morgan, 2016). Three-quarters of women imprisoned for fine default in Western Australia are not employed, in comparison to 10% of males (Morgan, 2016). Socioeconomic factors including homelessness can also lead to prisoners being detained on remand in circumstances where they would otherwise be released before trial (Ayres, Heggie, & de Almeida Neto, 2010). While it is well established that women prisoners experience high levels of socioeconomic disadvantage, the policy discussion around short term, remand, and fine default imprisonments has not extended to consider the potential implications of these for children with incarcerated mothers.

We found that for children aged less than 2 years, rates of contact with the child protection system were almost identical for Indigenous and non-Indigenous children whose mothers were imprisoned during pregnancy or before their second birthday. However, twice the number of Indigenous compared to non-Indigenous children had their mother imprisoned between pregnancy and their second birthday. This is of concern given that less than 7% of Western Australian children under 4 years old are Indigenous (ABS, 2011). The over-representation of Indigenous children within the child protection system has been well established (Delfabbro, Hirte, Rogers, & Wilson, 2010). Our study findings raise the question of how much of the over-representation of young Indigenous children in the child protection system may be related to the over-representation of Indigenous women in the prison system. The removal of Indigenous children from families is a pertinent issue in Australia, with some commentators expressing concerns in the wake of the rise in numbers of Indigenous children in care (Lavarch, 2016).

It would be valuable to explore whether there is any association between the timing of maternal incarceration and child protection contact but this is beyond the scope of the present paper given the complexities we have reported of prison exposure in terms of frequency and duration, and taking account of similar complexities of the timing, frequency and nature of child protection system contacts, familial relationships and additional contributing factors. The magnitude of our findings suggest the interaction between maternal incarceration and exposure of children to the child protection system is significant. The relationship between maternal incarceration, child protection and juvenile justice system involvement is clearly an important area for future research.

Our study found that infant mortality rates for children of mothers with a history of imprisonment were over twice the rate for children of mothers with no corrections record. This equated to an additional 13.1 deaths per 1000 Indigenous births and 4.4 deaths per 1000 non-Indigenous births, for children whose mothers have a history of imprisonment. While we were unable to calculate rates for women imprisoned during pregnancy separately, the international literature on the birth outcomes of women imprisoned during pregnancy has found improved birth outcomes, including birth weight, for women imprisoned during pregnancy compared to women imprisoned at other times and worse birth outcomes compared to women who are never imprisoned (Knight, & Plugge, 2005). However, these findings were not replicated by the only Australian study to date by Walker, Hilder,

Levy, and Sullivan (2014), which found similarly poor birth outcomes for women imprisoned while pregnant compared to women imprisoned at other times. The authors questioned whether this was in part due to the shorter imprisonment terms within the New South Wales female prison population compared to those in the United States (Walker et al., 2014). Our findings highlight the increased risk of infant mortality for children born to mothers with a history of imprisonment. Further research is needed, however, to establish whether the experience of maternal incarceration itself increases children's infant mortality risk, or whether it is acting as a marker of extreme vulnerability.

Limitations

The sampling methodology for the broader longitudinal study, from which the data were drawn, primarily identified children whose mothers had at least one record of imprisonment after their birth to their 18th-birthday. While it was possible to identify women who were imprisoned while pregnant, the sample did not include a full census of women imprisoned during pregnancy in Western Australia. Possible implications of this would be an underreporting of the proportion of Western Australian female prisoners who are pregnant, however, we found similar proportions of female prisoners who are imprisoned while pregnant as Australian-wide data (Australian Institute of Health and Welfare, 2014). Thus any error is likely to be small.

Data were not available on gestational age and the day of birth, accordingly the date of commencement of pregnancy was taken as nine-months before the first day of a child's birth month. This may have included some mothers who were not yet pregnant at time of imprisonment, but were at least nine months away from giving birth. Research has shown, however, that the preconception period (approximately 6 months prior to conception) is also an important time when the experience of maternal stress during this period can impact on the health of the conceived child (Class, Khashan, Lichtenstein, Långström, & D'Onofrio, 2013).

Conclusions

This is the first Australian study to report the extent of the population of infant children of women prisoners in contact with the child protection system. The results confirm that infant children of women prisoners are a highly vulnerable population who experience a significantly increased risk of engagement with the child protection system and placement in out-of-home care. These children also experience high rates of infant death compared to children of mothers with no corrective services history. The findings also demonstrate that many imprisoned mothers of young children are held on remand, for short periods of time and for non-violent crimes. This study highlights the importance of considering the heterogeneity of timing and frequency of imprisonment within the prison population on outcomes for families and children.

Abbreviations

ABS: Australian Bureau of Statistics; COAG: Council of Australian Governments; OECD: Organisation for Economic Co-operation and Development; WADLS: Western Australian Data Linkage System

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Material presented cannot be considered as either endorsed by the Western Australian Department of Justice or an expression of the policies or view of the Department, and any errors or omission or commission are the responsibility of the Researchers.
Responsibility for interpretation of the data supplied through the Government of Western Australia, the Developmental Pathways in Western Australian Children Project, and by any other data custodian, is the Researchers' alone.

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Availability of data and materials

This study used linked routinely-collected administrative data from the Western Australian Departments of Health, Justice, and Communities: Child Protection and Family Support. While these data are accessible to approved researchers through the standard ethical and data application processes, they are not publicly available and are maintained by the relevant government data custodians. As a result, while future researchers are able to apply directly for these data we are restricted under Statutory requirement from releasing any of our project data to a third party. This includes making the study data available in a publicly available repository.

Authors' contributions

CD had primary responsibility for the study design, conduct of the data analysis and interpretation, and drafting the initial and final versions of the manuscript. LS, GM and DP contributed to study design, interpretation of findings and drafts of the manuscript. GM contributed to data analysis. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Ethical approval for the project was received from the Department of Health Human Research Ethics Committee, the Western Australian Aboriginal Health Ethics Committee, and the University of South Australia Human Research Ethics Committee.

Consent for publication

The study uses data that is routinely collected by the Department of Justice and other Western Australian Government departments and services and linked for research purposes by the Western Australian Data Linkage Branch. In cases such as this the National Health and Medical Research Council outlines in the National Statement on Conduct in Human Research the requirements for waiver of consent. Under the National Statement, a Human Research Ethics Council can grant a waiver of consent if it is satisfied certain

conditions have been met. The criteria for allowing a waiver listed under the National Statement apply to the project. Specifically as the project carries no more than a low risk; it is not feasible to obtain consent due to the age and quantity of the data required; and measures are being taken to ensure the continued protection of the confidentiality of the data.

Competing interests
The authors declare that they have no competing interests.

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RESEARCH ARTICLE Open Access

Determinants of infant mortality for children of women prisoners: a longitudinal linked data study

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Abstract

Background: There is limited information on the determinants of infant mortality outcomes for the children of women prisoners. This study aimed to explore determinants of infant mortality for Indigenous and non-Indigenous children, with a specific focus on maternal imprisonment during pregnancy as a risk factor.

Methods: Using linked administrative data we obtained a longitudinal sample of 42,674 infants born in Western Australia between October 1985 and June 2013. Data were analysed by maternal contact with corrective services, including; (i) imprisonment during pregnancy, (ii) imprisonment before (but not during) pregnancy, (iii) imprisonment after birth, (iv) community-based correctional orders (but no imprisonment), and (v) no corrections record. Infant mortality rates were calculated. Univariate and multivariate log-binomial regression was undertaken to identify key demographic and pregnancy-related risk factors for infant mortality. Risk factor prevalence was calculated for infants by maternal corrections history.

Results: 430 Indigenous and 116 non-Indigenous infants died aged 0–12 months. For singletons, infant mortality rates were highest in Indigenous infants with mothers imprisoned during pregnancy (32.1 per 1000) and non-Indigenous infants whose mothers were first imprisoned after birth (14.2 per 1000). For all Indigenous children, the strongest determinants of infant mortality were: abruptio placentae and other placental disorders (RR = 2.85; 95%CI 1.46–5.59; $p = 0.002$), maternal imprisonment during pregnancy (RR = 2.55; 95%CI 1.69–3.86; $p < 0.001$), and multiple gestation (RR = 2.29; 95% CI1.51–3.46; $p < 0.001$). Indigenous and non-Indigenous infants with mothers imprisoned at any time, and particularly before or during pregnancy, experienced higher prevalence of key pregnancy risk factors.

Conclusions: This is the first comprehensive study of the determinants of infant mortality for children of women prisoners. Infants with any maternal corrections history, including community-based orders or imprisonment outside of pregnancy, had increased infant mortality. Indigenous infants whose mothers were imprisoned during pregnancy were at particular risk. There was a low incidence of infant death in the non-Indigenous sample which limited the investigation of the impact of the specific aspects of maternal corrections history on infant mortality. Non-Indigenous Infants whose mothers were imprisoned before or during pregnancy experienced higher prevalence of pregnancy risk factors than infants of mothers first imprisoned after birth.

Keywords: Infant mortality, Women prisoners, Linked data, Australia

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Background

Women prisoners constitute a highly vulnerable population which is exposed to multiple and complex risk factors, including domestic violence, substance abuse, poverty, discrimination and mental illness, placing them and their children at risk of poor pregnancy and health outcomes [1]. However, few reports, exist which have investigated pregnancy outcomes for children of women prisoners [2, 3]. Of those studies that have investigated pregnancy outcomes for infants, the main outcomes investigated include preterm delivery and low birth weight [3]. The few studies that report on infant death have been limited by small numbers of events, in part due to the size of the cohort sampled [3, 4].

While the international literature on the pregnancy outcomes of prisoners is equivocal, a review of studies from across the United States (US), United Kingdom and Europe found women imprisoned in pregnancy generally had poorer maternal and infant outcomes than community controls, and better outcomes than disadvantaged community controls [3]. It has been concluded that this may indicate that imprisonment in pregnancy may be beneficial for some pregnancy outcomes [3]. The only Australian study on pregnancy outcomes of women prisoners found, however, that women imprisoned during pregnancy did not have better perinatal outcomes than women imprisoned at times other than pregnancy [4]. Thus the unique context of the justice systems and prisoner populations in specific jurisdictions limit the transferability of findings across jurisdictions in the absence of an understanding of the determinants of pregnancy outcomes for women prisoners.

Studies in the US have found racial differences in the pregnancy outcomes of women prisoners [5]. In Australia, research on the pregnancy outcomes of Indigenous women prisoners is lacking despite their overrepresentation in the prison population. In Western Australia, for example, Indigenous peoples represent 4% of the general population but 46% of the female prison population [6, 7]. This reflects the high levels of social and economic disadvantage and discrimination experienced by Indigenous peoples in Australia [8]. Similarly, Indigenous peoples in Australia experience poorer pregnancy outcomes compared with non-Indigenous mothers, and while infant mortality rates have been improving for both Indigenous and non-Indigenous populations across time, the racial disparity remains [9, 10].

Across 1980 to 2001, infant mortality rates in Western Australia declined for both Indigenous (25.0 in 1980–84 to 16.1 in 1998–2001) and non-Indigenous infants (8.4 in 1980–84 to 3.7 in 1998–2001) [10]. Some important changes that occurred across the past 30-years include improved transport for rural and remote pregnant women, immunisation of infants, prevention of Sudden Infant Death Syndrome [10], as well as increased parental employment and maternal education [11]. Although the overall rates of infant mortality declined between 1980 and 2001, the disparity between Indigenous and non-Indigenous populations increased from a Relative Risk of 3.0 (95%CI 2.5–3.6) in 1980–84 to 4.4 (95%CI 3.5–5.5) in 1998–2001 [10]. For Indigenous infants, postneonatal mortality was higher than neonatal mortality, a pattern that indicates the impact of socioeconomic disadvantage and marginalisation on infant mortality outcomes [10].

The primary objective of this study was to explore determinants of infant mortality for Indigenous and non-Indigenous children, with a focus on whether maternal imprisonment during pregnancy is a risk factor for infant mortality. The specific aims of the study were to determine: infant mortality rates for Indigenous and non-Indigenous infants of mothers with different corrections histories; the key demographic and pregnancy-related risk factors which may contribute to infant mortality in Indigenous and non-Indigenous populations; the importance of maternal corrections history as a determinant of infant mortality after accounting for significant demographic and pregnancy-related risk factors; and the prevalence of key risk factors for infant mortality between infants with different maternal corrections histories.

Methods

Study design

We have used data from a large data linkage project to explore infant mortality within Indigenous and non-Indigenous children of mothers who have been exposed to the corrections system at different times in relation to their pregnancy. We compared infant mortality outcomes for children whose mothers had; (i) any period of imprisonment during pregnancy, (ii) imprisonment before (but not during) pregnancy, (iii) their first period of imprisonment after birth, (iv) community-based correctional orders (but no imprisonment), or (v) no corrections record at any time over the study period.

Conceptual framework

Mosley and Chen's [12] analytical framework for the study of child survival was adapted for the present study. The basis of this framework is that broader determinants necessarily act through biological pathways, or mechanisms, which impact before, during and after pregnancy on the healthy development of the fetus and infant, and ultimately on infant mortality. There is evidence that adverse events experienced before and during pregnancy can impact on fetal development and result in increased risk of poor infant and childhood health outcomes [13–17].

Our adaptation of this framework first groups together key demographic factors, including birth year, sex, Indigenous status, socioeconomic status, and geographical remoteness. The second grouping includes baseline pregnancy risk factors, such as multiple gestation, birth spacing < 18 months, maternal age, and parity, which are largely unmodifiable from the commencement of pregnancy [18]. The third grouping includes key pregnancy complications that might be a precursor of infant mortality, such as nutritional deficiencies, placental disorders, prematurity, and infection [19]. The last group includes other maternal factors and exposures which are known risk factors for infant mortality or may indicate maternal vulnerability or household dysfunction, such as substance use or mental health related service contacts, external causes of injury, and having other children in contact with the child protection system.

Data sources

Data were obtained through the Western Australian Data Linkage System (WADLS). The WADLS uses highly-accurate computerised, probabilistic matching with clerical review to create linkages within and between administrative data collections across a range of Western Australian government agencies [20]. The Western Australian Data Linkage Branch conducted the linkage and provided de-identified data extracts. Records were extracted from the Midwives Notifications System, Birth Registrations, Death Registrations, Department of Justice, Hospital Morbidity Data System Collection (HMDC), Mental Health Information System (MHIS), and Department of Communities: Child Protection and Family Support (CPFS) data collections. These are all statutory State-wide data collections with complete coverage.

The Birth Registration and Midwives Notifications System data provided social and demographic characteristics of mothers and children at time of birth. Mortality data include all deaths registered in Western Australia. The Department of Justice data collection includes all custodial records for offenders held in Western Australian prisons and records for offenders on community-based correctional orders. Data excluded unsentenced individuals detained in police stations and courts, immigration detention centres, and mental health facilities. The HMDC includes all inpatient records for Western Australian public and private hospitals and day surgeries. The MHIS includes presentations to all inpatient and public community mental health services. The CPFS data include all reports of concerns for child welfare made to the child protection system and the details of investigations, protection applications and orders as well as placements in out-of-home care.

The Death Registrations, HMDC, and MHIS use the International Classification of Diseases (ICD), to classify cause of death, diagnosis, or reason for health service contact, respectively. For HMDC records, we obtained one code for the principal diagnosis of the episode of care, and up to four codes for external causes of episodes of care. Over the study period, the ICD 9th Revision with Clinical Modification (ICD-9-CM) [21] related to services contacts before July 1999, and service contacts from that date used ICD 10th Revision with Australian Modification (ICD-10-AM) [22].

Study population

The study population was drawn from a retrospective longitudinal cohort study of all liveborn children born in Western Australia from 1985 to 2011 whose biological mother was imprisoned at least once within 18-years after their birth. The cohort study population included a comparison group of children whose mother had no record of imprisonment from their date of birth to their 18th birthday, which was identified through the same data sources as the cohort and matched 3:1 to cohort children on Indigenous status, age and sex. Data on second-generation children, born between 1998 and 2014 to the female members of the cohort and comparison group, were also obtained.

Stillbirths (second-generation only) and infants with chromosomal abnormalities, identified through HMDC and death records, were excluded (Fig. 1). Erroneous records with multiple mothers or missing key information such as birthdate were removed. The final study population was restricted to children born from October 1985 to June 2013 (inclusive) to ensure pregnancy exposure and death data was available for all infants.

In total, there were 42,674 infants in the final study population, 37,469 from the first-generation (original cohort and comparison group) and 5205 from the second-generation (children of the original cohort and comparison group). Data from the birth and death registrations, midwives notifications records, and CPFS data were available for first- and second-generation children. Only first-generation children had HMDC record data. Mothers had corrections, HMDC, and MHIS data available.

Definition of maternal corrections history

The study population was categorised into: a) infants whose mothers had a record of imprisonment at any time ($n = 7317$ Indigenous; $n = 3504$ non-Indigenous); b) infants whose mothers had community-based correctional orders but no record of imprisonment ($n = 5828$ Indigenous; $n = 653$ non-Indigenous); and c) infants whose mothers had no record within any Department of Justice database ($n = 12{,}817$ Indigenous; $n = 12{,}555$ non-Indigenous).

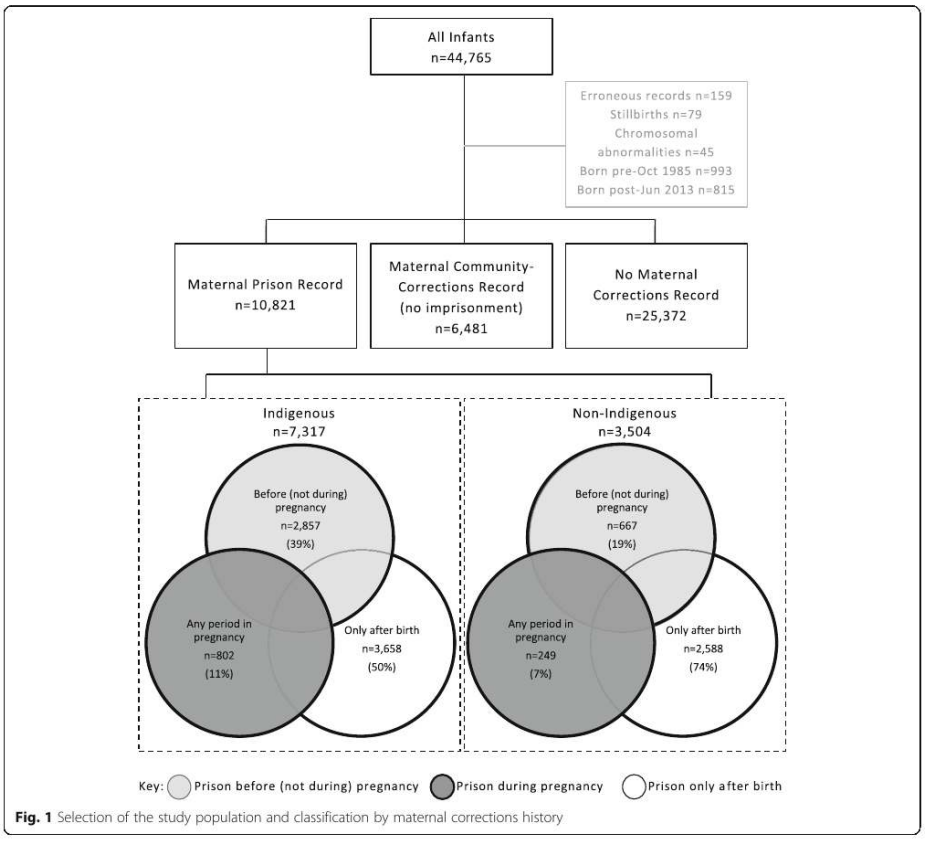


Fig. 1 Selection of the study population and classification by maternal corrections history

Imprisonment records covered prison stays of any length of time, and included unsentenced remandees detained before trial as well as sentenced prisoners. Infants of mothers who had a prison record at any time over the study period were further categorised based on the timing of their mother's imprisonment in relation to their pregnancy. The first group included infants whose mothers had any record of imprisonment during pregnancy. The second group included infants whose mothers had imprisonment records in the period before, but not during, pregnancy. The third group included infants whose mothers first record of imprisonment only occurred after the child's birth. These groupings are shown in Fig. 1. Classifications were based on mother's prison reception dates and the infant's birth date.

Community-based sentences may involve treatment or vocational programs, community service, and place restrictions on offenders. Breach of conditions while on community orders may result in imprisonment. Accordingly, women with community-based correctional orders are sentenced offenders, but may differ to women given custodial prison sentences in terms of severity or frequency of their offending and other individual factors. They are not exposed to the prison environment which generally places more stringent conditions on offenders and has different implications for them and their families.

The proportion of infants in the various maternal corrections history sub-groups (Fig. 1) relate only to the study sample and do not reflect the prevalence of these groups across the whole Western Australian population.

Pregnancy and birth dates

Child month and year of birth was provided by the Midwives Notification System, or if missing from the Birth Registration data. As gestational age was not available, pregnancy start date was calculated as being nine months before the first day of the child's birth-month.

Definition of infant mortality

Infant mortality was defined as the death of a live born child under one year of age [23]. Full date of death was provided in the death registration data, however, birth data were available only for month and year of birth. Accordingly, infant mortality was defined as death within 12-full months after birth. For example, for a child born in January 2000, death on or before 31 January 2001 would be determined within the category of infant mortality.

Demographic characteristics

The Birth Registration and Midwives Notifications System data provides social and demographic characteristics of mothers and children at time of birth, including sex, socioeconomic status and geographical remoteness. Sex was taken primarily from Midwives Data, or if missing from Birth Data.

Area-based socio-economic status of infant's place of residence at time of birth was assigned using the Socio-economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage [24]. The smallest area of SEIFA reporting is Collectors District (CD) level, which is approximately 250 households or less in rural areas. Missing CD scores were imputed with mean CD-score by postcode before using broader area scores of SEFIA available for Statistical Local Area or Local Government Area [25].

The Accessibility/Remoteness Index of Australia (ARIA) [26] was used to classify the geographical remoteness of infant's place of residence at time of birth. ARIA is derived from the measure of place of residence to populated locations and key services and classified as major cities, inner regional, outer regional, remote, and very remote locations. For the current study major cities and inner regional areas were combined given both have greater accessibility of relevant services [26].

Indigenous status for infants and mothers in the study populations was ascertained from the Derived Indigenous Status Flag variable generated by the WADLS using best-practice algorithms, which assess individuals' Indigenous status across multiple data collections to enhance accuracy [27].

Baseline pregnancy risk factors

Maternal birth date was determined using all available data sources. Maternal age was calculated as the age of mother at time of birth. Birth date was available for all siblings which enabled parity and duration of birth spacing to be determined. Multiple gestation pregnancies were also derived based on siblings having shared birth dates or through maternal or child HDMC data. Child-level HDMC data were not obtained for the second-generation children, however, as stillbirths were captured for the second-generation this assisted in identifying multiple gestation pregnancies.

Pregnancy complications

The separate and combined effects of key pregnancy complications identified from maternal hospital records were evaluated. Pregnancy complications included the effects of infection-related hospitalisations, anaemia, diabetes, hypertension, preeclampsia, eclampsia, abruptio placentae, placenta previa, other placental disorders, premature rupture of membranes and renal disorders during pregnancy on infant mortality (Additional file 1) [19]. Complications were excluded due to low incidence or non-significance ($p > 0.05$), including hospitalisations for anaemia, diabetes, hypertension, preeclampsia, and eclampsia (Additional file 1).

Other maternal risk factors and exposures

Maternal substance use (including alcohol) and poisoning-related service contacts during pregnancy were identified from HMDC and MHIS data. Maternal hospital admissions for any injuries from external causes, excluding substance use, self-harm and poisoning-related contacts were identified during pregnancy. Maternal hospital admissions for mental and behavioural disorders, self-harm, and mental health service presentations, both excluding substance use and poisoning-related contacts, were identified during pregnancy from HMDC and MHIS data. Having an older sibling in contact with child protection services during the infant's pregnancy was also identified using sibling's child protection data.

Statistical analyses

All analyses were conducted using Stata Version 14.0. All analyses were stratified by Indigenous status of the infants.

Infant mortality rates (per 1000 population) were calculated for singleton infants by maternal corrections history. Prevalence of demographic and pregnancy-related risk factors were calculated for Indigenous and non-Indigenous populations. Log-binomial regression was used to calculate the Relative Risk of infant death for all univariate and multivariate analyses.

The strength of correlation between all variables of interest was assessed using Chi-square tests with Cramer's V statistic. For variable pairs with a medium effect size (> 0.3) [28], one variable was excluded from further multivariate

analysis on the basis of the univariate Relative Risk and level of statistical significance of each variable with infant mortality. Multivariate regression was then conducted for each grouping of variables (demographic factors, baseline pregnancy risk factors, pregnancy complications, and other maternal factors and exposures) separately with infant mortality, and variables that were not statistically significant ($p < 0.05$) were excluded from further analysis (Additional file 2). All remaining variables were entered with maternal corrections history into a full regression model (Model 1). Variables were removed by key groups; other maternal factors and exposures (Model 2), pregnancy complications (Model 3), baseline pregnancy risk factors (Model 4), leaving the combined effects of maternal corrections history and demographic factors with infant mortality. Goodness of model fit was assessed from the Akaike Information Criterion (AIC) value. There were insufficient numbers of non-Indigenous infant deaths whose mothers were imprisoned before or during pregnancy to undertake multivariate regression for non-Indigenous children.

Prevalence of key demographic and pregnancy-related risk factors, as determined from the univariate and multivariate analyses, were calculated for each maternal corrections history grouping and by Indigenous status.

Results

In total, 546 infants in the sample died aged 0 to 12 months, between October 1985 and June 2014. There was a 2.39-fold risk of infant mortality for Indigenous infants compared to non-Indigenous infants (95% CI: 1.95–2.93, $p < 0.001$).

Infant mortality by maternal corrections history

For singleton births, Indigenous infants whose mothers were imprisoned at any time had a significantly higher risk of death than infants of mothers with community corrections orders alone, or with no corrections history (Table 1). Indigenous infants whose mothers were imprisoned during pregnancy had the highest rates of infant mortality (32.1 per 1000), compared to infants whose mothers were imprisoned either only before pregnancy (22.1 per 1000) or after birth (23.6 per 1000) (Table 1).

In non-Indigenous infants, those whose mothers were imprisoned before (9.4 per 1000) or during (8.2 per 1000) pregnancy had apparently lower rates of infant mortality than those whose mothers were imprisoned for the first time after their birth (14.2 per 1000) or who had community orders alone (12.6 per 1000). This difference was not significant and confidence intervals wide, possibly due to the low numbers of infant deaths within the sample of non-Indigenous children with mothers imprisoned before or during pregnancy.

Univariate analysis of infant mortality

As shown in Table 2, abruptio placentae and other placental disorders (excluding placenta previa) were associated with the highest risk of death for both Indigenous and non-Indigenous infants. Other important risk factors for Indigenous and non-Indigenous infants were low socioeconomic status, multiple gestation pregnancies, birth spacing < 18-months, having an older sibling in contact with the child protection system during an infant's gestation, and maternal substance use or poisoning-related service contacts during pregnancy.

Maternal hospitalisations for premature rupture of membranes, or external causes of injury were important risk factors for infant mortality only for Indigenous infants. Male sex was also only a risk factor for infants in the Indigenous subgroup. Young maternal age and geographical location for those living in outer regional areas, were only significant risk factors in the non-Indigenous sample.

Factors not strongly associated with infant death included parity, infection related hospitalisations, or mental health related service contact (not related to substance use) in pregnancy, and hospital admissions for placenta previa.

Table 1 Infant mortality for singleton births, by maternal corrections history and Indigenous status

	Indigenous infants						Non-Indigenous infants					
	Survived	Died					Survived	Died				
	n	*n*	IMR[a]	RR	(95% CI)	*p*-value	*n*	*n*	IMR[a]	RR	(95% CI)	*p*-value
Maternal corrections history												
Prison (before pregnancy[b])	2742	62	22.1	1.95	(1.45–2.62)	<.001	634	6	9.4	2.25	(0.97–5.22)	0.059
Prison (during pregnancy)	753	25	32.1	2.84	(1.87–4.31)	<.001	243	< 5	8.2	1.96	(0.48–8.00)	0.349
Prison (after birth only)	3481	84	23.6	2.08	(1.59–2.72)	<.001	2491	36	14.2	3.42	(2.24–5.23)	<.001
Community corrections	5588	94	16.5	1.46	(1.13–1.89)	0.004	628	8	12.6	3.02	(1.44–6.33)	0.003
No corrections*	12,400	142	11.3				12,186	51	4.2			

Note Excludes 591 Indigenous and 427 non-Indigenous multiples births
[a]Infant mortality rate: deaths under 12 months, per 1000 live births
[b]Prison before, but not during, pregnancy

Table 2 Risk factors for infant mortality, by Indigenous status

	Indigenous infants (*n* = 25,962)						Non-Indigenous infants (*n* = 16,712)					
	Survived	Died					Survived	Died				
	n	*n*	%	RR	(95% CI)	*p*-value	*n*	*n*	%	RR	(95% CI)	*p*-value
Infants	25,532	430	1.7				16,596	116	0.7			
Demographic factors												
Sex[a]												
Male	13,052	240	1.8	1.20	(0.99–1.45)	0.058	8586	64	0.7	1.14	(0.79–1.65)	0.468
Female*	12,438	190	1.5				7991	52	0.6			
Maternal Indigenous status												
Indigenous	24,321	418	1.7	1.72	(0.97–3.05)	0.062						
Non-Indigenous*	1211	12	1.0				16,596	116	0.7			
Socioeconomic status[b]												
Very low (0–5%)	6793	128	1.8	2.16	(1.38–3.39)	0.001	996	15	1.5	3.50	(1.88–6.54)	<.001
Low (6–25%)	11,095	195	1.7	2.02	(1.30–3.13)	0.002	4461	50	1.1	2.62	(1.65–4.15)	<.001
Medium (26–50%)	5054	83	1.6	1.89	(1.18–3.01)	0.008	4517	23	0.5	1.20	(0.69–2.07)	0.523
High (51–100%)*	2546	22	0.9				6584	28	0.4			
Geographical remoteness[c]												
Major cities/Inner regional*	10,331	160	1.5				13,574	88	0.6			
Outer regional	4185	73	1.7	1.12	(0.85–1.48)	0.404	1811	22	1.2	1.86	(1.17–2.97)	0.009
Remote	4776	75	1.5	1.01	(0.77–1.33)	0.922	834	5	0.6	0.93	(0.38–2.27)	0.865
Very remote	6195	120	1.9	1.25	(0.98–1.58)	0.066	326	< 5	0.3	0.47	(0.07–3.40)	0.458
Baseline Pregnancy Risk Factors												
Multiple gestation												
Yes	568	23	3.9	2.43	(1.61–3.66)	<.001	414	13	3.0	4.81	(2.73–8.50)	<.001
No*	24,964	407	1.6				16,182	103	0.6			
Birth spacing												
< 18 months	3011	82	2.7	1.74	(1.37–2.21)	<.001	1112	19	1.7	2.70	(1.66–4.40)	<.001
Firstborn/18 months+*	22,521	348	1.5				15,484	97	0.6			
Maternal age												
12–19 years	7628	122	1.6	0.91	(0.72–1.17)	0.471	1740	21	1.2	2.36	(1.41–3.94)	0.001
20–24 years	9420	158	1.6	0.96	(0.76–1.20)	0.713	3916	47	1.2	2.35	(1.57–3.52)	<.001
25–34 years*	7533	132	1.7				9054	46	0.5			
35 + years	951	18	1.9	1.08	(0.66–1.76)	0.761	1886	< 5	0.1	0.21	(0.05–0.86)	0.030
Parity												
Nulliparous	9035	126	1.4	0.82	(0.66–1.03)	0.093	7954	53	0.7	0.99	(0.67–1.45)	0.939
Parity 1–2*	10,847	184	1.7				7539	51	0.7			
Parity 3+	5650	120	2.1	1.25	(0.99–1.57)	0.058	1103	12	1.1	1.60	(0.86–2.99)	0.140
Pregnancy complications												
Abruptio placentae and other disorders[d]												
Yes	122	8	6.2	3.77	(1.91–7.42)	<.001	90	< 5	4.3	6.31	(2.38–16.8)	<.001
No*	25,410	422	1.6				16,506	112	0.7			
Placenta previa												
Yes	87	< 5	3.3	2.02	(0.66–6.17)	0.217	109	0	0			
No*	25,445	427	1.7				16,487	116	0.7			

Table 2 Risk factors for infant mortality, by Indigenous status *(Continued)*

	Indigenous infants (*n* = 25,962)						Non-Indigenous infants (*n* = 16,712)					
	Survived	Died					Survived	Died				
	n	*n*	%	RR	(95% CI)	*p*-value	*n*	*n*	%	RR	(95% CI)	*p*-value
Premature rupture of membranes												
Yes	1200	34	2.8	1.72	(1.22–2.43)	0.002	445	5	1.1	1.63	(0.67–3.97)	0.284
No*	24,332	396	1.6				16,151	111	0.7			
Infection related hospitalisation in pregnancy[e]												
Yes	2041	34	1.6	0.99	(0.70–1.40)	0.947	388	< 5	0.5	0.73	(0.18–2.96)	0.664
No*	23,491	396	1.7				16,208	114	0.7			
Other maternal factors/Exposures during pregnancy												
Substance use related service contact[f]												
Yes	397	15	3.6	2.24	(1.35–3.72)	0.002	293	6	2.0	2.99	(1.33–6.76)	0.008
No*	25,135	415	1.6				16,303	110	0.7			
Hospitalisation for external causes of injury[g]												
Yes	1479	38	2.5	1.56	(1.12–2.17)	0.008	278	< 5	1.1	1.55	(0.50–4.86)	0.450
No*	24,053	392	1.6				16,318	113	0.7			
Mental health related service contact[h]												
Yes	768	12	1.5	0.93	(0.52–1.64)	0.794	427	5	1.2	1.70	(0.70–4.14)	0.244
No*	24,764	418	1.7				16,169	111	0.7			
Sibling in contact with child protection[i]												
Yes	852	30	3.4	2.13	(1.48–3.07)	<.001	237	6	2.5	3.70	(1.64–8.33)	0.002
Firstborn/No*	24,680	400	1.6				16,359	110	0.7			

*Reference category
[a]42 Indigenous and 19 non-Indigenous infants missing sex
[b]46 Indigenous and 38 non-Indigenous infants missing socioeconomic status
[c]47 Indigenous and 51 non-Indigenous infants missing remoteness
[d]Excludes placenta previa
[e]Infection related hospitalisation in pregnancy
[f]Substance use (including alcohol) or poisoning related service contact (hospital or mental health service)
[g]Hospitalisation for external causes of injury in pregnancy (excludes poisoning)
[h]Mental health service contact in pregnancy (excludes substance use) (hospital or mental health service)
[i]Older sibling(s) in contact with child protection system in infant's pregnancy

Multivariate regression of indigenous infant mortality

Multivariate regression was only performed for Indigenous children because of the low number of deaths in the sample of non-Indigenous infants with incarcerated mothers.

Variables for maternal Indigenous status, geographical remoteness, maternal age, parity, placenta previa, infection-related hospitalisations, external injury-related hospitalisations, and mental health related service contacts in pregnancy (other than for substance use) were excluded based on their lack of association with infant mortality in our data (Additional file 2). The remaining variables were included and are shown in Model 1 (Table 3). In Models 2–4, variables were removed by group in order of; other maternal factors and exposures (Model 2), pregnancy complications (Model 3), baseline pregnancy risk factors (Model 4), leaving the combined effects of maternal corrections history and demographic factors on infant mortality in Model 4.

The best model fit was achieved with the inclusion of all variables (i.e., Model 1). Abruptio placentae and other placental disorders contributed the highest risk of infant death, followed by maternal imprisonment during pregnancy, and multiple gestation pregnancy. The effect of birth year remained stable across Models 1–4 and approximated to a 4% reduction in risk of infant mortality each year.

Prevalence of key demographic and pregnancy risk factors by maternal corrections history

Table 4 shows the prevalence of pregnancy risk factors selected from the previous univariate and multivariate analyses, for Indigenous and non-Indigenous infants reported by their mothers' contact with corrective services.

Infants of mothers with any corrections history had, in most instances, higher prevalence of maternal service contact in pregnancy for substance use (including poisoning), external causes of injury, mental health related service

Table 3 Regression model of infant mortality, Indigenous children

	Model 1			Model 2			Model 3			Model 4		
	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value	RR	(95% CI)	*p*-value
Maternal corrections history												
Prison (before pregnancy*)	1.83	(1.36–2.47)	<.001	1.99	(1.49–2.67)	<.001	2.03	(1.51–2.71)	<.001	2.10	(1.57–2.81)	<.001
Prison (during pregnancy)	2.55	(1.69–3.86)	<.001	2.96	(1.98–4.43)	<.001	3.01	(2.01–4.51)	<.001	3.10	(2.07–4.64)	<.001
Prison (after birth only)	1.55	(1.18–2.03)	0.001	1.64	(1.25–2.14)	<.001	1.67	(1.28–2.18)	<.001	1.73	(1.32–2.25)	<.001
Community-only	1.38	(1.07–1.77)	0.012	1.41	(1.10–1.81)	0.007	1.42	(1.11–1.83)	0.006	1.45	(1.13–1.87)	0.003
No corrections history	ref.											
Demographic factors												
Birth year	0.96	(0.95–0.97)	<.001	0.96	(0.95–0.98)	<.001	0.96	(0.95–0.98)	<.001	0.97	(0.95–0.98)	<.001
Sex												
Male	1.21	(1.01–1.47)	0.044	1.22	(1.01–1.47)	0.039	1.22	(1.01–1.47)	0.038	1.22	(1.01–1.48)	0.036
Female	ref.											
Socioeconomic status												
Very low (0–5%)	2.11	(1.35–3.31)	0.001	2.08	(1.33–3.27)	0.001	2.1	(1.34–3.30)	0.001	2.11	(1.34–3.31)	0.001
Low (6–25%)	1.88	(1.21–2.91)	0.005	1.86	(1.20–2.88)	0.006	1.87	(1.20–2.89)	0.005	1.91	(1.23–2.96)	0.004
Medium (26–50%)	1.75	(1.10–2.80)	0.018	1.74	(1.09–2.78)	0.02	1.75	(1.10–2.79)	0.019	1.78	(1.11–2.83)	0.016
High (51–100%)	ref.											
Baseline pregnancy risk factors												
Multiple gestation												
Yes	2.29	(1.51–3.46)	<.001	2.37	(1.57–3.59)	<.001	2.58	(1.71–3.88)	<.001			
No	ref.											
Birth spacing												
< 18 months	1.52	(1.19–1.93)	0.001	1.57	(1.24–2.00)	<.001	1.60	(1.26–2.03)	<.001			
Firstborn/18 months+	ref.											
Pregnancy complications												
Abruptio placentae and other disorders[a]												
Yes	2.85	(1.46–5.59)	0.002	2.92	(1.49–5.72)	0.002						
No	ref.											
Premature rupture of membranes												
Yes	1.66	(1.18–2.35)	0.004	1.67	(1.18–2.37)	0.003						
No	ref.											
Other maternal factors/exposures in pregnancy												
Substance use related service contact												
Yes	1.71	(1.02–2.87)	0.042									
No	ref.											
External injury related hospitalisation												
Yes	1.20	(0.86–1.68)	0.283									
No	ref.											
Sibling with Child Protection contact												
Yes	1.57	(1.07–2.31)	0.022									
Firstborn/No	ref.											
Observations	25,875			25,875			25,875			265,875		
AIC	0.1640			0.1642			0.1646			0.1656		

*Prison before, but not during, pregnancy
[a]Excludes placenta previa

Table 4 Prevalence of pregnancy risk factors for infant mortality, by maternal corrections exposure and Indigenous status

	Indigenous infants					Non-Indigenous infants				
	Prison (before preg.)	Prison (during preg.)	Prison (after birth)	Community correct.	No correct.	Prison (before preg.)	Prison (during preg.)	Prison (after birth)	Community correct	No correct
	n = 2857	*n* = 802	*n* = 3658	*n* = 5828	*n* = 12,817	*n* = 667	*n* = 249	*n* = 2588	*n* = 653	*n* = 12,555
Very low (0–5%) SES[a]										
%	22.9	22.7	29.1	29.8	25.7	13.3	13.4	12.8	12.3	3.8
RR	0.89	0.88	1.13	1.16	ref.	3.48	3.49	3.35	3.20	ref.
p-value	0.002	0.057	<.001	<.001		<.001	<.001	<.001	<.001	
Multiple gestation										
%	1.9	3.0	2.5	2.5	2.1	4.0	1.6	2.4	2.6	2.5
RR	0.86	1.39	1.18	1.17	ref.	1.60	0.63	0.93	1.03	ref.
p-value	0.328	0.113	0.152	0.126		0.017	0.362	0.602	0.911	
Birth spacing < 18mths										
%	17.9	11.2	14.1	12.8	9.6	12.7	8.0	9.8	10.4	5.6
RR	1.87	1.17	1.47	1.34	ref.	2.27	1.43	1.75	1.86	ref.
p-value	<.001	0.127	<.001	<.001		<.001	0.099	<.001	<.001	
Maternal age < 20 yrs.										
%	15.3	28.6	41.7	33.1	28.3	9.3	10	25.9	26	6.6
RR	0.54	1.01	1.47	1.17	ref.	1.40	1.51	3.91	3.92	ref.
p-value	<.001	0.895	<.001	<.001		0.007	0.032	<.001	<.001	
Placental disorders[b]										
%	0.5	0.7	0.6	0.7	0.4	0.1	0.8	1.1	1.1	0.4
RR	1.17	1.92	1.54	1.72	ref.	0.34	1.83	2.56	2.45	ref.
p-value	0.620	0.130	0.090	0.011		0.288	0.398	<.001	0.025	
PROM[c]										
%	6.8	5.5	5.1	5.2	4.0	5.5	3.2	3.7	3.2	2.3
RR	1.71	1.39	1.28	1.32	ref.	2.41	1.4	1.59	1.40	ref.
p-value	<.001	0.032	0.003	<.001		<.001	0.344	<.001	0.133	
Substance use[d]										
%	3.2	7.4	2.2	1.6	0.7	12.3	10.0	4.7	3.2	0.4
RR	4.64	10.59	3.15	2.27	ref.	30.87	25.21	11.74	8.08	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	
External injury[e]										

Table 4 Prevalence of pregnancy risk factors for infant mortality, by maternal corrections exposure and Indigenous status *(Continued)*

	Indigenous infants					Non-Indigenous infants				
	Prison (before preg.)	Prison (during preg.)	Prison (after birth)	Community correct.	No correct.	Prison (before preg.)	Prison (during preg.)	Prison (after birth)	Community correct	No correct
	n = 2857	*n* = 802	*n* = 3658	*n* = 5828	*n* = 12,817	*n* = 667	*n* = 249	*n* = 2588	*n* = 653	*n* = 12,555
%	10.9	14.5	9.4	6.5	2.9	6.9	6.4	3.4	2.1	0.9
RR	3.78	5.02	3.26	2.25	ref.	7.46	6.95	3.72	2.32	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	0.003	
Mental health contact[f]										
%	6.7	8.4	3.6	3.1	1.6	13.5	10.8	5.0	5.1	1.2
RR	4.20	5.22	2.27	1.96	ref.	11.15	8.96	4.15	4.17	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	
Sibling in contact CP[g]										
%	11.6	14.3	5.2	2.6	0.7	12.9	11.2	4.4	1.5	0.05
RR	15.68	19.35	6.97	3.50	ref.	269.80	235.30	91.36	32.04	ref.
p-value	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	

[a]46 Indigenous and 38 non-Indigenous infants missing socioeconomic status
[b]Excludes placenta previa
[c]Premature rupture of membranes
[d]Substance use (including alcohol) or poisoning related service contact (Mental Health or Hospital)
[e]Hospitalisation for external causes of injury in pregnancy (excludes poisoning)
[f]Mental health related service contact in pregnancy (excludes substance use) (Mental Health or Hospital)
[g]Older sibling(s) in contact with child protection system in infant's pregnancy

contacts, and sibling contact with the child protection system compared to infants whose mothers had no record with corrective services. Prevalence of these service contacts in pregnancy was highest for infants whose mothers were imprisoned during pregnancy, and higher for infants whose mothers were imprisoned before pregnancy compared to those imprisoned for the first time after birth or who had community corrections orders for these service contacts.

The proportion of infants born in areas of very low socioeconomic status was high for all groups of Indigenous children (> 20%) and did not differ by maternal corrections history. There was a higher proportion of low socioeconomic status for non-Indigenous children with any maternal corrections record (12–13%) compared to those with no maternal corrections history (4%).

There was a higher prevalence of a birth spacing of less than 18-months for infants with any maternal corrections record compared to no maternal corrections history, except the difference was not significant for those infants whose mothers were imprisoned during pregnancy. The prevalence of infants born to mothers aged less than 20 years was highest among infants whose mothers were first imprisoned after birth or had community-corrections orders.

For Indigenous children, maternal hospitalisation for abruptio placentae and other placental disorders (excluding placenta previa) was not different between infants by maternal corrections history, whereas prevalence of maternal hospitalisation for premature rupture of membranes was higher where there had been any record of maternal contact with the corrections system.

For the non-Indigenous children, hospitalisation of the mother for abruptio placentae and other placental disorders (excluding placenta previa) was higher where infants' mothers were first imprisoned after birth or had community-correctional orders, and prevalence of hospitalisation for premature rupture of membranes was higher where infants' mothers were imprisoned before or after pregnancy.

Discussion

This is the first study to provide a comprehensive investigation of infant mortality outcomes for children of women prisoners. Children of mothers with a history of contact with corrective services, including community-based corrections orders and imprisonment before or after pregnancy, had increased rates of infant mortality.

Within the Indigenous sample, rates of infant mortality were highest for infants whose mothers were imprisoned during pregnancy, when compared to similarly disadvantaged mothers who were imprisoned at times other than pregnancy or who had community-based correctional orders. The strength of the relationship between infant mortality and maternal imprisonment in pregnancy for Indigenous infants remained in the full model after adjusting for other important risk factors. The only determinant to have a greater association with Indigenous infant mortality was abruptio placentae and other placental disorders, a serious pregnancy complication. Imprisonment during pregnancy was a stronger determinant of infant mortality than all other pregnancy complications and baseline pregnancy risk factors including multiple gestation pregnancies. Indigenous infants whose mothers were imprisoned during pregnancy also experienced the highest prevalence of maternal contact with services during pregnancy for substance use, mental illness, and external injury. These findings clearly demonstrate the significant vulnerability of Indigenous infants whose mothers are imprisoned during pregnancy.

It was not possible to determine the relationship between maternal imprisonment before and during pregnancy and the risk of infant mortality for non-Indigenous infants due to the relatively small numbers of infants in the sample populations whose mothers were imprisoned before or during pregnancy. However, non-Indigenous infants whose mothers who were imprisoned before or during pregnancy had a significantly higher prevalence of several pregnancy risk factors including maternal service contact in pregnancy for substance use, external injury, or mental health issues, and having siblings in contact with the child protection system, compared to non-Indigenous infants whose mothers were first imprisoned after birth or had community-based corrections orders alone.

Infant mortality is a marker of adversity which is strongly linked to social and economic disadvantage [10]. It is well-established that Indigenous children experience higher rates of socioeconomic disadvantage and infant mortality than non-Indigenous children [10, 29]. Over a quarter of our Indigenous subgroup, compared to only 6% of the non-Indigenous sample, was born in the lowest 5% of areas by socioeconomic status. Socioeconomic disadvantage provides a broad measure of social determinants such as parental education, employment, disability, and overcrowding as well as a greater prevalence of health conditions and risk behaviours such as alcohol and substance use, domestic violence, and mental illness, which are related to infant mortality risk. For Indigenous peoples, socioeconomic disadvantage is also associated with experiences of racism and discrimination in service access and broader society, and in increased contact with health and criminal justice systems [30].

It is recognised that imprisonment likely acts as both a proxy for socioeconomic disadvantage and for risk behaviours which are associated with imprisonment, including increased substance use, injury and mental illness, as evidenced in our study by increased prevalence of service contacts related to these risks in

pregnancy for pregnant prisoners. Similarly, having a sibling in contact with the child protection system during pregnancy can be considered as a proxy for maternal vulnerability and socioeconomic disadvantage. Whether maternal imprisonment during pregnancy has an impact on birth outcomes, including infant mortality, over-and-above the effects of pre-existing disadvantage, is a key issue within the international literature [3].

It has been proposed that there may be a possible protective effect of imprisonment in pregnancy for birth outcomes [3]. The proposed protective effect of imprisonment in pregnancy on birth outcomes is thought to be contributed to by a reduction of exposure to risk factors such as domestic violence and substance use while in custody, and in improved nutrition and access to antenatal care. Within our study, infants whose mothers were imprisoned before pregnancy had a higher prevalence of risk factors during pregnancy related to maternal service contact for substance use, injury, and mental illness, when compared to infants whose mothers were first imprisoned after birth. This finding suggests that risk behaviours of this kind do occur concurrently with imprisonment. However, the strength of our findings with respect to maternal imprisonment during pregnancy for Indigenous infants suggest there may be an additional impact of imprisonment during pregnancy on infant mortality risk, at least in certain circumstances.

Similar to our findings, the general protective effect of imprisonment during pregnancy on birth outcomes that has been reported in the broader international literature was not replicated in the only prior Australian study of the effects of maternal imprisonment on pregnancy outcomes [4]. While just over one-quarter of pregnant prisoners were Indigenous, Walker and colleagues [4] did not investigate the outcomes for the Indigenous and non-Indigenous populations separately. Our study has clearly demonstrated that infant mortality is higher for Western Australian Indigenous infants whose mothers were imprisoned during pregnancy. Taken together, our study and that of Walker and colleagues [4] suggest that there are different outcomes for the infants of Australian women imprisoned during pregnancy than those reported for other jurisdictions [3]. It is not yet clear, however, whether this difference is restricted to the Indigenous population as our findings were inconclusive, due to small numbers, with respect to non-Indigenous infants.

The difference in outcomes for Australian pregnant prisoners compared to those within other criminal justice systems reported in the international literature [3], may relate to the longer periods of imprisonment experienced by women in other jurisdictions compared to Australia, as an increased length of imprisonment in pregnancy is associated with higher birth weight which represents a positive pregnancy outcome [31, 32]. For example, Walker and colleagues [4] reported the average length of stay for sentenced women prisoners in New South Wales, Australia, is 196 days compared to 547 days in US prisons [4]. In our study of Western Australian children exposed to maternal incarceration before their second birthday, almost half of all prison stays for either sentenced prisoners or unsentenced remandees were < 2 weeks [33]. In this context the presumption that imprisonment has a 'dose-response' effect on perinatal outcomes [32], and that short-term imprisonment does not carry excess risks for the mother or her infant warrants further research.

Within Western Australia, all pregnant prisoners are provided with health care "commensurate with community standards" [34]. However, health service provision varies between prisons [35–40], and regional prisons face additional challenges such as in the transportation of prisoners to community health centres [41]. There is limited evidence available on the provision and impact of antenatal care provided to pregnant prisoners in Australia. In New South Wales, Walker and colleagues [4] found that women imprisoned during pregnancy were more likely to initiate antenatal care after 20 weeks gestation than women with no record of imprisonment. However as many of these women were not imprisoned for the duration of pregnancy, as was the case for women in the present study, it is possible antenatal care was first initiated during imprisonment.

Imprisonment during pregnancy may have negative impacts on the mental health and wellbeing of women, particularly for Indigenous mothers, as a consequence of being separated from family and country during their pregnancy [42]. There is evidence that maternal stress in pregnancy can impact on birth outcomes [43, 44]. Research on offender health has demonstrated that the year following release from prison, particularly within the first month of release, is also a key risk period for an offender's own hospitalisation and mortality [45–48]. Whether the release period also leads to increased risk for offenders' children, including the unborn children of pregnant prisoners, has not been investigated. The results from the present study highlight that this as an important area of future research.

Further research is needed to understand whether there are particular characteristics of maternal imprisonment during pregnancy that are associated with infant mortality, and whether the effect is restricted to Indigenous populations. The study findings highlight the importance of separate consideration of Indigenous populations when investigating outcomes for children of prisoners, as combining populations may mask important differences in outcomes.

Limitations

These results need to be considered within the context of the study's limitations, for example, the power to detect relationships between infant mortality and maternal imprisonment before or during pregnancy in the non-Indigenous sample was limited by the small numbers of non-Indigenous infant deaths reported within those groups.

As gestational age was not available, pregnancy was taken to begin nine-months prior to month of birth for all infants. Accordingly, some records of exposure to maternal imprisonment, and service contacts related to substance use, mental health or child protection, that were attributed to having occurred during pregnancy may have occurred prior to pregnancy if gestation was shorter than nine-months. There is evidence, however, that adverse events within the preconception period (6–0 months before pregnancy) can increase infant mortality risk [49, 50]. Therefore any records of exposure misclassified as having occurred during pregnancy, may still have been expected to have an impact on infant mortality risk.

Additionally, without gestational age we have not been able to measure preterm birth (delivery before 37 weeks of gestation), which is associated with infant mortality [51]. However, preterm birth shares many of the same risk factors for infant mortality identified within the study including low socioeconomic status, maternal age, maternal stress, infections, and multiple gestation pregnancies [51]. The study has provided the first evidence of an association between maternal incarceration in pregnancy and infant mortality, further research is needed investigate the impact of factors not able to be measured in the current study, notably preterm birth, antenatal care and caesarean section rates.

Administrative data alone cannot fully capture occurrences of heavy drinking or substance use, mental illness, or injuries resulting from domestic violence, within pregnancy [52]. In addition, the study only obtained the primary diagnosis code (not co-diagnoses) for hospital and mental health service records. Consequently, the associations observed in our study with drinking or other substance use in pregnancy, mental illness or injuries are likely under ascertained.

Hospital data were not obtained for second-generation children. While explanatory variables based on hospital data were primarily taken from maternal hospital records (available for all mothers), there may have been some missed cases of chromosomal abnormalities, and substance use related service contacts in pregnancy, for the second-generation children.

Conclusions

To date there have been few studies which have focussed on the impact of maternal imprisonment on infant mortality. This study provides the first detailed analysis of infant mortality outcomes for children whose mothers were imprisoned in pregnancy. The study demonstrates that there are higher rates of infant mortality for Indigenous, compared to non-Indigenous, children of prisoners and that within the Indigenous sample any maternal contact with the corrections system is associated with an increase in infant mortality.

Maternal imprisonment in pregnancy is an important determinant of infant mortality for Indigenous children. Further research is needed to determine what factors contribute to this increased risk of infant mortality, and whether particular groups of prisoners are more affected. Due to the relatively low incidence of infant deaths within the non-Indigenous sample, it was not possible to determine the impact of maternal imprisonment on infant mortality in this sub-population. It was the case, however, that non-Indigenous infants whose mothers were imprisoned before or during pregnancy experienced higher rates of pregnancy risk factors, than infants whose mothers were first imprisoned after birth or had community-based correctional orders. This highlights the vulnerability of non-Indigenous and Indigenous pregnant prisoners, and the importance of providing support services to address pregnancy risk factors for women in contact with the corrections system.

Additional files

Additional file 1: ICD codes. List of ICD codes used to define the study variables. (PDF 393 kb)

Additional file 2: Regression models of infant mortality by main group for Indigenous children. Results of the multivariate regression conducted for each main grouping of variables to eliminate non-significant variables from including the final multivariate analysis. (PDF 330 kb)

Abbreviations

AIC: Akaike Information Criterion; ARIA: Accessibility/Remoteness Index of Australia; CPFS: Department of Communities: Child Protection and Family Support; HMDC: Hospital Morbidity Data System Collection; ICD: International Classification of Diseases; MHIS: Mental Health Information System; SEIFA: Socio-economic Indexes for Areas; WADLS: Western Australian Data Linkage System

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Responsibility for interpretation of the data supplied through the Government of Western Australia, the Developmental Pathways in Western

Australian Children Project, and by any other data custodian, is the Researchers' alone.

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Availability of data and materials
This study used linked routinely-collected administrative data from the Western Australian Departments of Health, Justice, and Communities: Child Protection and Family Support. While these data are accessible to approved researchers through the standard ethical and data application processes, they are not publicly available and are maintained by the relevant government data custodians. As a result, while future researchers are able to apply directly for these data we are restricted under Statutory requirement from releasing any of our project data to a third party. This includes making the study data available in a publicly available repository.

Authors' contributions
CD had primary responsibility of the study design, conduct of the data analysis and interpretation, and drafting the initial and final versions of the manuscript. LS, GM and DP contributed to the study design, interpretation of findings and drafts of the manuscript. GM contributed to the data analysis. All authors read and approved the final manuscript.

Ethics approval and consent to participate
Ethical approval for the project was received from the Department of Health Human Research Ethics Committee, the Western Australian Aboriginal Health Ethics Committee, and the University of South Australia Human Research Ethics Committee.
The study uses data that is routinely collected by the Department of Justice and other Western Australian Government departments and services and linked for research purposes by the Western Australian Data Linkage Branch. In cases such as this the National Health and Medical Research Council outlines in the National Statement on Conduct in Human Research the requirements for waiver of consent. Under the National Statement, a Human Research Ethics Council can grant a waiver of consent if it is satisfied certain conditions have been met. The criteria for allowing a waiver listed under the National Statement apply to the project. Specifically as the project carries no more than a low risk; it is not feasible to obtain consent due to the age and quantity of the data required; and measures are being taken to ensure the continued protection of the confidentiality of the data.

Competing interests
The authors declare that they have no competing interests.

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Appendix K Ethics approvals and letters of community support

Aboriginal Legal Rights Movement Inc

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Reply To:

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19 November 2013

To Whom It May Concern,

Re. Letter in support of proposed research on children of incarcerated mothers

It is my pleasure to provide a letter of support on behalf of the Aboriginal Legal Rights Movement Inc. (ALRM) for the proposed research project titled: 'Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts'.

ALRM is an independent Aboriginal community controlled organisation governed by an all Aboriginal Board. ALRM promotes legal, cultural, economic, political and social rights for Aboriginal and Torres Strait Islander peoples within South Australia, through the provision of legal services and support programs.

I have discussed the proposed project with Ms Caitlin Dowell from the University of South Australia and I have reviewed a copy of the research protocol. I believe the project will generate important knowledge for advocating for improved services for women and children in the criminal justice system.

Caitlin has approached me to be a member of the Project Advisory Group to provide guidance throughout the duration of the project. I am looking forward to this ongoing collaboration with the research team.

Sincerely,

[redacted]

Ms Cheryl Axleby
CEO, Aboriginal Legal Rights Movement Inc.

22 November 2013

Prof Leonie Segal
University of South Australia
Adelaide, South Australia

Dear Professor Segal,

RESEARCH PROJECT

I write in support of your research project *'Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts'.*

I feel the research project is important and I support it as a Noongar elder and through my professional role as a Community Liaison Officer for the Office of the Inspector of Custodial Services.

As a Noongar elder I aim to be an active participant in my local community. I have coached the local football team and currently sit as a member on the Aboriginal Alcohol Drug Service Board. I have a strong interest in human rights and I have participated in many human rights working groups including, the United Nations Special Rapporteur on the Situation of Human Rights and Fundamental Freedoms of Indigenous Peoples Group and the Youth Justice Campaign through Amnesty International. Through these activities, and others, I have created strong relationships with Noongar families. Many of these families have been impacted by incarceration and I have seen the negative consequences of this incarceration on Noongar people.

In addition, as a Community Liaison Officer for the Office of the Inspector of Custodial Services, I am responsible for developing and fostering relationships with the Aboriginal community across Western Australia. I also network with many volunteer organisations and stakeholders who provide services in custodial settings (including those who support the female estate). My role is also responsible for raising issues relating to the welfare of Aboriginal prisoners. This often requires me to facilitate focus groups with prisoners and detainees and to participate in liaison and inspection activities in custodial settings. As a result I regularly interact with Aboriginal women of different kin groups and ages within custodial environments.

As a result of my professional experiences and my understandings of the Noongar community I am particularly concerned with how Aboriginal women's needs are not being met within custodial environments in the Western Australian Justice system. Accordingly I think the proposed research project is incredibly important and timely.

Thank you for inviting me to sit on the project's Advisory Panel. I look forward to being involved and discussing the research with you further as the project moves forwards.
Yours sincerely,

[redacted]

Mr Joseph Wallam
24 Cunningham Loop
MIRRABOOKA WA 6061

Government of **Western Australia**
Department of **Corrective Services**

20 November 2013

Prof Leonie Segal
University of South Australia
Adelaide, South Australia

Dear Professor Segal,

I am happy to provide this letter in support of your project titled '*Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts*'.

In my role as the Cultural Consultant Project Officer I work within the Department to establish appropriate cultural practices for staff and customers of the Department regarding working with people who have diverse needs.

In providing this research it would highlight how Aboriginal women's needs are currently being met in the Western Australian justice system and I believe that the proposed research project will make a valuable contribution towards informing future policy in this area.

Thank you for the invitation to be part of an Advisory Panel for the research. I welcome the opportunity to be involved with the future development of the project.

Yours sincerely,

[redacted]

Ms Josephine Maxted (BSW)
Cultural Consultant Project Officer

Aboriginal Family Law Services

21 November 2013

To Whom It May Concern,

Re: Letter of Support for Children of Incarcerated Mothers Project

The Western Australian Family Violence Prevention Legal Service Aboriginal Corporation (WAFVPLS) is pleased to present this letter in support of the proposed research project titled: 'Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts'.

WAFVPLS provides legal representation and community education to Aboriginal people in Western Australia in the areas of family and sexual violence.

The WAFVPLS has six regional offices throughout the state and is supported by the corporate office which is located in East Victory Park.

I am concerned with how Aboriginal women's needs are currently being met in the Western Australian justice system and I believe this project will generate important knowledge for advocating for improved services for women and children in the criminal justice system.

Caitlin has approached me to be a member of the Project Advisory Panel to provide guidance throughout the duration of the project. I am looking forward to this ongoing collaboration with the research team.

Yours Sincerely,

[redacted]

Ms Mariette Cowley

CEO, Western Australian Family Violence Prevention Legal Service Aboriginal Corporation

Helping to prevent family violence for a safer community.
Aboriginal Family Law Services WA
890 Albany Highway East Victoria Park 6101 • PO Box 5254, East Victoria Park, WA 6981
P 08 9355 1502 or 1800 469 246 • F 08 9355 0890 • afls.org.au

Seeds of Affinity
Pathways for women Inc.
PO Box 292, Welland SA 5007
Email: seedsoa@adam.com.au
Ph: 8242 7210

18 November 2013

Ms Caitlin Dowell
PhD Student, Health Economics and Social Policy Group
School of Population Health,
University of South Australia
Email: caitlin.dowell@mymail.unisa.edu.au

Dear Caitlin,

Re: Meeting held at Seeds of Affinity on Tues 12th of November 2013

Thank you for coming to speak to us about your research project. We would like to advise you that the women from Seeds of Affinity have agreed to support you in your research proposal, as we can see the benefits this can have for women in prison and their children.

Therefore, we are prepared to send a delegation from Seeds of Affinity to be a part of your reference group and participate in follow up discussions. These women will include women with lived prison experience and current Board members:

- ~~Linda~~ Saqipi
- Michelle
- Trish
- Andrea Duff
- Petra Nisi
- Pam Price

If you have any queries, please feel free to contact me.

Kind regards,

Yours sincerely,

[redacted]
Patricia Waria-Read
Chairperson

Western Australian Aboriginal Health Ethics Committee

AHCWA
Aboriginal Health Council of Western Australia

13th February 2014

Dear Leonie,

RE: HREC Reference number: 543
Title: Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts.

Thank you for submitting the above research project which was considered by the WAAHEC at its meeting held on *4th February 2014*.

I am pleased to advise that the WAAHEC has granted approval of this research project.
WAAHEC approval is granted from *4th February 2014* pending your agreement of the following conditions:

1.Conditions

- The WAAHEC will be notified, giving reasons, if the project is discontinued before the expected date of completion.
- The Coordinating Investigator will provide an annual report to the WAAHEC and at completion of the study in the specified format. This form can be found on the AHCWA website (www.ahcwa.org).
- The approval for studies is for three years and the research should be commenced and completed within that period of time. Projects must be resubmitted if an extension of time is required.
- Publications that arise from this research are to be provided to the WAAHEC for review prior to submission for dissemination.
- That the Aboriginal and Torres Strait Islander community are formally acknowledged for their contribution to this research project.

2.Amendments

If there is an event requiring amendments to be submitted you should immediately contact ethics@ahcwa.org for advice.

450 Beaufort Street, Highgate WA 6003 / PO Box 8493, Stirling Street, Perth WA 6849
Phone: (08) 9227 1631 Fax: (08) 9228 1099 Email: reception@ahcwa.org Web: www.ahcwa.org.au ABN: 48 114 220 478 ACN: 114 220 478

Should you have any queries about the WAAHEC's consideration of your project please contact ethics@ahcwa.org.

The WAAHEC wishes you every success in your research.

Kind regards

[redacted]

Chelsea Bell
For
Tammy Prouse
Chair, WAAHEC

This HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007), NHMRC and Universities Australia Australian Code for the Responsible Conduct of Research (2007) and the CPMP/ICH Note for Guidance on Good Clinical Practice.* The process this HREC uses to review multi-centre research proposals has been certified by the NHMRC.

450 Beaufort Street, Highgate WA 6003 / PO Box 8493, Stirling Street, Perth WA 6849
Phone: (08) 9227 1631 Fax: (08) 9228 1099 Email: reception@ahcwa.org Web: www.ahcwa.org.au ABN: 48 114 220 478 ACN: 114 220 478

Department of **Corrective Services**
Government of **Western Australia**

Policy and Strategy Division

Professor Leonie Segal
University of South Australia
CEA-24
GPO Box 2471
ADELAIDE SA 5001

By post and email to: leonie.segal@unisa.edu.au

Dear Professor Segal

REC Project ID: 337 – Modelling Linked Population Data to Understand and Improve Long Term Outcomes for Children of Incarcerated Mothers to Reduce Social and Economic Impacts

Thank you for your research application. The Department of Corrective Services has considered your research proposal and is pleased to support the research (*in principle*) subject to the receipt of the signed Researchers' Code of Conduct. Please email the signed Code of Conduct to REC@correctiveservices.wa.gov.au.

It is a Departmental requirement that all researchers having direct access to the Department's data/clients/facilities agree to the conditions specified in the Code of Conduct prior to commencing their research.

In particular, I draw your attention to the requirement that the Department:

- receives reports on the progress of your research on an annual basis or as specified, starting from the approval date; and
- reviews any papers prior to their release (publication, marking, etc). For this reason, please note that the Department requires a copy of any final reports 20 working days prior to their intended release.

I wish you all the best with your research and look forward to learning about your research outcomes and results.

Yours sincerely,

[redacted]

Ian D'Mello
Manager, Organisational Strategy and Performance
Department of Corrective Services

12 July 2013

Encl: Researchers' Code of Conduct
Cc: Dr Rebecca Glauert and Caitlin Dowell

Level 8, 141 St Georges Terrace Perth Western Australia 6000
Locked Bag 22 Cloisters Square Perth Western Australia 6850
Telephone (08) 9264 1822 Facsimile (08) 9485 0045
Website: www.correctiveservices.wa.gov.au
ABN 25 103 389 163

Telethon Institute for Child Health Research

12th June, 2013

Developmental Pathways in WA Children Project

RESEARCH MANAGEMENT GROUP EXPRESSION OF INTEREST FEEDBACK

Project: Modelling linked population data to understand and improve long-term outcomes for children of incarcerated mothers to reduce social and economic impacts

Dear Caitlin Dowell,

Thank you for submitting an Expression of Interest [EOI] to the Developmental Pathways in WA Children Project [DPP] on behalf of Principal Researcher Professor Leonie Segal.

Your application for the use of cross-agency linked data through the DPP was tabled at a meeting of the DPP Research Management Group [RMG] held on 27th May, 2013.

The RMG is kept informed of all scientific, research and management issues related to the DPP and is comprised of representatives from each of the government agencies, staff from the Telethon Institute for Child Health Research [TICHR] and TICHR researchers involved in the DPP.

In assessing the acceptability of the project, members from the RMG considered all documents provided and gave the following feedback:

- It would be beneficial to include mothers with semi-exposure and no exposure to the justice system in the project. There may be large differences between mothers who have one or two contacts, compared with those who have multiple contacts.
- The project would significantly benefit from having someone with experience on women in the justice system included on the project.

100 Roberts Rd, Subiaco WA 6008 • PO Box 855, West Perth WA 6872
Telephone +61 8 9489 7777 • Facsimile +61 8 9489 7700 • enquire@ichr.uwa.edu.au • **www.ichr.uwa.edu.au** • ABN 86 009 278 755
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Telethon Institute for Child Health Research

Thus, we are happy to approve this project, once the applicant addresses the comments above.

Applicants are also required to have the project approved by each government agency that will potentially supply data, and a number of government agencies have their own research review committees. If the project is requesting data from a government agency with their own internal research committee, the researcher is required to submit an application to each relevant committee.

For this particular project, this will include applications to the DCS Research Evaluation Committee [REC] (http://www.correctiveservices.wa.gov.au/about-us/statistics-publications/students-researchers/default.aspx.

Once the feedback from the RMG has been addressed, the next step in this process is to submit an EOI to the Data Linkage Unit [DLU]. Details can be found at http://www.datalinkage-wa.org/access-and-application/application-process.

We recommend applicants contact the Project Manager at the DLU, Alexandra Godfrey (t: 08 9222 2370, e: alexandra.godfrey@health.wa.gov.au) to discuss any fees that may be associated with the linkage and extraction of data for the project.

The Principal Researcher must also obtain approval from the Department of Health WA [DoHWA] Human Research Ethics Committee [HREC]. More information can be found at http://www.health.wa.gov.au/healthdata/HREC/ . If the proposed study population includes people of Aboriginal or Torres Strait Islander descent then applicants are also required to apply to the Western Australian Aboriginal Health Information and Ethics Committee [WAAHIEC].

The progression of a research project depends upon receipt of approvals from these groups, in addition to any others specified by them. Data linkage keys will only be released when applicants have approval from the DLU and each individual government agency whose data the project requires access to.

By using linked data through the DPP, applicants agree to the terms and conditions outlined in the application package and are required to sign the attached Data Contract Form: User Agreement. As stated in the agreement, applicants are required to acknowledge the DPP and relevant Industry Partners in all project outputs, including any publication or presentation to

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Research

arise from use of the data, and to seek comment and input from the Industry Partners prior to any public release. Please see the Intellectual Property Agreement for further detail.

Please do not hesitate to contact me if you have any further queries.

We wish you well in your research project and look forward to hearing updates on your progress.

Kind regards

[redacted]

Dr Rebecca Glauert
Program Manager
Developmental Pathways in WA Children Project
Telethon Institute for Child Health Research
t: +61 (8) 9489 7754
e: rglauert@ichr.uwa.edu.au

Government of **Western Australia**
Department of **Health**

HUMAN RESEARCH ETHICS COMMITTEE AHEC EC00422

Postal Address:
Executive Officer
DOHWA HREC
Level 1, C Block
189 Royal Street
EAST PERTH WA 6004

ph: (08) 9222 4278
fax: (08) 9222 4236
e-mail: HREC@health.wa.gov.au
http://www.health.wa.gov.au/healthdata/hrec/

Prof Leonie Segal
Research Chair
University of South Australia
CEA-09, GPO Box 2471
ADELAIDE SA 5001

Dear Prof Segal

Project 2013/72: Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts

Date of commencement:	01/01/2014
Date of next annual progress report:	01/01/2015
Research team:	Leonie Segal, David Preen, Kim Dalziel and Caitlin Dowell
DOH data required:	Yes
Data linkage required:	Yes
Datasets to be accessed:	Mental Health Information System, Mortality Register, Hospital Morbidity Data System and Birth Registrations
Date of ethical review:	13/11/2013
Ethics approval validity:	31/11/2017

I am pleased to advise that the Department of Health WA Human Research Ethics Committee (DOH HREC) has granted **ethical approval** for this project.

The Committee considered your application under *the National Statement on Ethical Conduct in Human Research 2.3.6* and was satisfied that it met the criteria to grant a waiver of consent.

This letter constitutes ethics approval only. You will not receive the data requested for your project until the release of the data has also been approved by the data steward.

As Principal Investigator you are responsible for the ethical conduct of the project and the security of the personal health information.

This approval is subject to your continued compliance with your obligations under the Practice Code for the Use of Personal Health Information including the following conditions. You are required to:

1. Report to the DOH HREC anything which might warrant review of ethical approval of the project including;
   - any breaches or complaints and any adverse events affecting the security and confidentiality of the data; and
   - unforeseen events that might affect the continued ethical acceptability of the project.

2. Notify the DOH HREC if the project is discontinued or withdrawn before the expected date of completion and to give reasons for this action.
3. Provide an annual progress report to the DOH HREC and a final report at the completion of the project.
4. Obtain approval from the DOH HREC for;
    - any changes or amendments to the research protocol, including methodology, data required, duration of the project and any changes to the approved data storage arrangements;
    - any changes of personnel in the research team, and provide a DOH Confidentiality Agreement/Confidentiality Acknowledgement form for any addition to the research team.

We wish you well with your project.

Yours sincerely



A/Professor Judy Allen
Chair
Department of Health WA Human Research Ethics Committee

18 November 2013

DOHWA HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) 'National Statement on Ethical Conduct in Human Research'. Applications are also reviewed for compliance with the Department of Health WA 'Practice Code for use of personal health information'.

Human Ethics: Application approved

no_reply@unisa.edu.au

Tue 25/02/2014 2:54 PM

To:Dowell, Caitlin McMillen - dowcm003 <caitlin.dowell@mymail.unisa.edu.au>; Leonie Segal <Leonie.Segal@unisa.edu.au>; david.preen@uwa.edu.au <david.preen@uwa.edu.au>; Research Ethics </o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=37053881247f4a5d90fc0818c1582bf4-RCHEthics>;

Dear Applicant

Re: Ethics protocol "Modelling linked population data to understand outcomes for children of incarcerated mothers and the role of the prison environment to reduce negative social and economic impacts" (Application ID: 0000032609)

Thank you for submitting your ethics protocol for consideration. Your protocol has been considered by the E1 Committee Review Group.

I am pleased to advise that your protocol has been granted ethics approval and meets the requirements of the National Statement on Ethical Conduct in Human Research. Please note that the E1 Committee Review Group's decision will be reported to the next meeting of the Human Research Ethics Committee for endorsement.

Please regard this email as formal notification of approval.

Ethics approval is always made on the basis of a number of conditions detailed at http://www.unisa.edu.au/res/forms/docs/humanresearchethics_conditions.doc; it is important that you are familiar with, and abide by, these conditions. It is also essential that you conduct all research according to UniSA guidelines, which can be found at http://www.unisa.edu.au/res/ethics/default.asp

Please note, if your project is a clinical trial you are required to register it in a publicly accessible trials registry prior to enrolment of the first participant (e.g. Australian New Zealand Clinical Trials Registry http://www.anzctr.org.au/) as a condition of ethics approval.

Best wishes for your research.

Executive Officer
UniSA's Human Research Ethics Committee
CRICOS provider number 00121B

This is an automated email and cannot be replied to. Please direct your query to ethics@unisa.edu.au.