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Title

Parsing components of risk of premature mortality in the children of mothers with severe mental illness

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Abstract

Introduction:

Children of mothers with severe mental illness are at increased risk of premature death including in infancy and early childhood. Importantly, these children are also more likely to be exposed to adverse socio-demographic risk factors and serious obstetric complications which, of themselves, may increase risk for childhood mortality. We examined mortality outcome at different ages up to 5 years taking account of these risks.

Method:

We used linked data across Western Australian whole-population psychiatric, inpatient, death, and midwives' registers to identify 15,486 births to mothers with severe mental illness and 452,459 births to mothers with no mental illness. Multivariable models were adjusted for exposure to adverse socio-demographic risk factors and serious obstetric complications.

Results:

Overall risk of premature death was increased among children of mothers with severe mental illness (2.3%, 354 deaths) compared with children of mothers with no mental illness (1.4%, 6,523 deaths); the same was true for specific risk of stillbirth, neonatal, post-neonatal and early childhood deaths. Risk was substantially attenuated after adjustment for adverse socio-demographic exposures, and further still after adjustment for exposure to serious obstetric complications. We observed no effects for the timing of maternal illness diagnosis.

Conclusions:

To minimise the risk of premature mortality in the children of mothers with severe mental illness, priority should be given to the prompt diagnosis of maternal mental illness with targeted delivery of high quality antenatal and psychiatric care, as well as social and structural supports for affected families that continue after birth.

Keywords:

premature childhood mortality;

maternal severe mental illness;

obstetric complications

Manuscript

1. Introduction

There is good evidence to suggest that the children of mothers with severe mental illness such as schizophrenia and other psychotic disorders are at increased risk of premature death including in infancy and early childhood compared to children of mothers with no mental illness. A meta-analysis of studies published since 1960 found that children of mothers with psychosis have an almost two-fold higher risk of perinatal and infant mortality (Webb et al., 2005). Since 2001, at least three high quality population studies using Scandinavian register data have reported significantly increased premature mortality in offspring of mothers with severe mental illness compared to mothers with no mental illness including stillbirth, neonatal death, post neonatal death and infant death (Bennedsen et al., 2001; King-Hele et al., 2009; Nilsson et al., 2002). Risks appear to be particularly high for offspring of mothers with schizophrenia and to persist into adulthood (Suvisaari et al., 2008; Webb et al., 2005).

Excess mortality may be associated with other factors associated with maternal mental illness rather than the illness itself. Importantly, children of women with a severe mental illness are more likely to be exposed to serious obstetric complications (Bennedsen, 1998; Howard, 2005; Jablensky et al., 2005; Morgan et al., 2012; Sacker et al., 1996), but no studies to date have assessed whether adverse obstetric environments mediate the association between maternal severe mental illness and infant mortality. In addition, women with schizophrenia are more likely to be exposed to socio-demographic disadvantages (Bennedsen, 1998; Nilsson et al., 2002; Stein et al., 2014) which may increase risk for childhood mortality. The timing of onset of maternal severe mental illness may also influence factors critical to infant outcomes. Nilsson et al reported that, compared to children of women, with no mental illness, children exposed to maternal schizophrenia diagnosed before birth were at higher risk of being preterm and of low birth weight (Nilsson et al., 2002). Jablensky et al reported similar findings for complications in each obstetric period: pregnancy, labour and delivery and neonatal (Jablensky et al., 2005). Women with severe mental illness are also likely to be exposed to antipsychotics and other psychotropic medications during pregnancy (Abel, 2013; Lanczik et al., 1998), some of which have been implicated in adverse offspring outcomes including premature mortality (Patton et al., 2002; Sorensen et al., 2015).

Far better understanding of the mechanisms behind excess mortality in this growing, under-researched group is needed, taking account of obstetric complications, socio-demographic disadvantage and the timing of maternal diagnosis relative to pregnancy and birth.

Therefore, we applied a uniquely comprehensive measure of obstetric complications to a high-quality, whole-population cohort to examine mortality in children of mothers with severe mental illness compared to children of mothers with no mental illness up to 5 years of age taking account of socio-demographic environments and timing of maternal mental illness.

2. Methods

2.1 Cohort population

This register-based study investigated a large, whole-population cohort of 467,945 children born in Western Australia between 1 January 1980 and 31 December 2001. The exposed group consisted of children born to mothers with a history of severe mental illness (15, 486 children, 7, 508 mothers); comparison children were born to mothers with no recorded history of any psychiatric disorder (452, 459 children, 239, 365 mothers). Children were identified on the Midwives' Notification System (Gee and Dawes, 1994), which includes mandatory, prospectively collected data on all infants born in Western Australia not restricted to live births. Mothers with severe mental illness were identified through linkage of records on the Midwives' Notification System to the Hospital Morbidity Data Collection and Mental Health Information System. Covariates used in analyses were from additional State registers. Linkage was carried out by the Data Linkage Branch of the Western Australian Department of Health. Full details on the linked registers used have been published elsewhere (Di Prinzio et al., 2018; Morgan et al., 2011).

2.2 Outcome variable: Mortality

Information on the study outcome, child mortality, was obtained from the West Australian Death Registry where primary cause of death is coded using ICD-9 and ICD-10 depending on date of death (Australian Bureau of Statistics, 2010). Mortality periods were constructed with deaths classified as: stillbirths (births of 20 or more weeks gestation or weighing 400 grams or more, but born dead); neonatal (born alive but died within 27 days of life); post-neonatal (died between 28 days and 364 days of life); and early childhood (died between one and less than five years of age). Some 342 births were recorded as stillbirths on the Midwives Notification but did not link to an entry in the Death Registry. They were included as stillbirths in analysis but cause of death was not available.

Deaths were further classified as a result of external or natural causes and whether they were potentially avoidable i.e. due to potentially preventable conditions through individualised care and/or treatable through existing primary or hospital care (Australian Institute of Health and Welfare, 2018). See supplementary Table 2.

2.3 Main exposure variables

2.3.1 Maternal severe mental illness

The primary exposure variable was maternal severe mental illness determined through the Hospital Morbidity Data Collection and Mental Health Information System, using entries from July 1966 to December 31, 2002. These registers cover records of all public and private inpatient hospital admissions, as well as public outpatient and ambulatory care contacts with mental health services

across the State. An iterative algorithm, based on the most recent diagnosis, was applied to all psychiatric records to determine presence of severe mental illness. ICD-9 codes used to identify specific disorders were: schizophrenia (295 – all); bipolar disorder (296.0, 296.2–296.5); unipolar major depression (296.1, 296.6, 296.8, 296.9); paranoid states (297 – all); and other nonorganic psychoses (298—all). ICD-8 and ICD-10 equivalents used in a small number of records were mapped to ICD-9.

2.3.2 Adverse socio-demographic exposures

Well-known risk factors influencing premature infant mortality, as well as socio-demographic variables, were included in adjusted analyses. Most of these were obtained from the Midwives Notification of Births and included **child's sex** and **sibling order**, **maternal age** and **marital status** at the time of the child's birth. **Indigenous status** of the mother was scored positive if she identified as Indigenous (of Aboriginal or Torres Strait Islander descent) in any of the data sources available.

Socioeconomic status was determined using the area-level Index of Relative Socio-Economic Disadvantage (Australian Bureau of Statistics, 2008). This index was associated with the mother's recorded residential address at the time of the child's birth.

The **geographical remoteness** of the mother's residence at the child's birth was determined using the census-derived area-level measure: the Australian Standard Geographic Classification - Remoteness Area (Australian Bureau of Statistics, 2006). Remoteness categories are classified as: Major City, Inner Regional, Outer Regional, Remote and Very Remote and their spatial coverage can be viewed in Supplementary Figure 1.

Paternal age at birth was extracted from State birth records. A binary variable, **father unknown**, indicating whether the child's father was registered on the birth record was included, as children with missing information on this variable (0.7% of the sample) were more frequently children of mothers with severe mental illness. **Paternal psychiatric morbidity** was ascertained through mental health inpatient admissions and ambulatory/outpatient contacts; psychotic illness was coded if there was history of schizophrenia, affective psychoses, paranoid disorders and/or other nonorganic psychoses (ICD-8 and ICD-10 mapped to ICD-9 295-298) and as another psychiatric illness for all other disorders in the ICD-8 and ICD-9 Chapter 5 range and ICD-10 F range for mental illness.

The **year of a child's birth** was included to account for period effects.

2.3.3 Adverse obstetric exposures

Individual obstetric complications were extracted from the Midwives Notification System which included pregnancy, labour and delivery and early neonatal complications, as well as baby's gestational age and weight and maternal demographic characteristics. A validated obstetric

complication scale, which took into account the timing of obstetric complications and their impact on the developing central nervous system, was used in order to assess the burden of multiple obstetric events on health outcomes for affected offspring.

To this end, each obstetric complication was scored using an adaptation of the clinically-derived McNeil-Sjöström Scale (Di Prinzio et al., 2018; McNeil and Sjöström, 1995) reflecting each obstetric complication's potential for negative effects on the exposed children's developing central nervous system, registered on a 6-point severity scale ranging from 1 ("not harmful or relevant") to 6 ("very great harm to or deviation in the offspring"). In the current study, subjects were defined as having had obstetric complications if they had at least one obstetric complication of critical severity categorised at severity level 4 ("potentially clearly harmful or relevant") or greater at any time during pregnancy, labour and delivery or the first few hours of the neonatal life. Examples of complications of critical severity include intrauterine growth restriction, fetal distress, maternal diabetes and pre-eclampsia amongst many others.

2.3.4 Onset of psychotic illness relative to the index birth

Binary variables were created that coded whether a mother's onset of severe mental illness (as recorded in the registers), had occurred before or after the beginning of the relevant mortality periods for the index birth (defined as conception for stillbirth, birth date for neonatal death, age 28 days for post neonatal death, and age 1 year for early childhood death).

2.4 Data analyses

Counts and percentages were used to describe demographic characteristics of the cohort. As mortality is a relatively rare event and our follow-up times are relatively short and are equal across all children, we were able to use multiple logistic regressions without loss of information (Green and Symons, 1983) to examine associations between maternal severe mental illness and child mortality, with and without adjustments for other factors. Estimates of odds ratios (ORs) with 95% confidence intervals were obtained. Examination of childhood mortality during distinct time periods allowed us to observe patterns in the relative effect sizes of the main covariates as the cohort aged.

Unadjusted analyses modelled associations between exposure to maternal severe mental illness and child mortality at different ages (stillbirth, neonatal death, post neonatal death and early childhood death (between 1 and 5 years)). These associations were then adjusted: in Model 1 for the block of socio-demographic variables; in Model 2 for socio-demographic variables and exposure to obstetric complications of critical severity. Finally, additional analyses were run, specifically to examine the effects of timing of onset of maternal illness, after adjustment for socio-demographic variables and exposure to obstetric complications of critical severity. In separate approaches, onset of maternal illness was coded as i) occurring either before the beginning of each mortality risk period or

during/after the mortality risk period and ii) as occurring either before or after *conception* for all risk periods beyond stillbirth. Because of the crude coding of onset in the multiple logistic regression models, a sensitivity analysis was also run fitting Cox proportional hazards models for each of the risk periods beyond stillbirth, with the time a child spent at risk of death apportioned between time spent at risk before their mother was diagnosed with severe mental illness and time after a mother's onset, to the nearest day. Interaction effects between mother's severe mental illness status and exposure to obstetric complications were assessed using log rank tests.

Only children alive at the beginning of a mortality period were included in analysis for that period. For example, children who were stillborn were excluded from the analyses of neonatal, post-neonatal and early childhood mortality. See Supplementary Figure 2. Children with a missing covariate were retained in analyses by including 'missing' categories for relevant variables. Levels of missing data were low and not considered to introduce bias. Robust standard errors were computed to protect against erroneous deflation of standard errors as a result of clustering of maternal sibships. Analyses were carried out using Stata v13 (StataCorp, 2013).

This study was approved by the Western Australian Department of Health Human Research Ethics Committee (2011/75) and The University of Western Australia Human Research Ethics Committee (RA/4/1/1322).

3. Results

3.1 Cohort characteristics

Demographic characteristics of the children appear in Table 1. Relative to children of mothers with no mental illness, children of mothers with severe mental illness were more likely to have: three or more siblings; single or indigenous mothers; mothers resident in an area of greater socioeconomic disadvantage or outside a major city; mothers or fathers younger than 20 years of age; and fathers who were unknown or had a history of psychiatric illness. These children also experienced higher rates of obstetric complications of critical severity (76.1%) than children of mothers with no mental illness (71.0%).

3.2 Mortality

A total of 6,877 children in our cohort (1.5%) died before the age of 5 years, including 3,351 who were stillborn (0.7%). Overall, mortality up to age 5 was higher amongst children born to mothers with severe mental illness (2.3%) compared to those born to mothers with no history of mental illness (1.4%) (Table 1 and Figure 1).

3.3 Mortality by maternal diagnosis, socio-demographic profile and exposure to obstetric complications

The unadjusted risk of mortality was increased for children of mothers with severe mental illness compared to children of mothers with no mental illness in all periods of premature death and risks were incremental with age of the child: stillbirth OR 1.2 (95% CI 1.02-1.5); neonatal death OR 1.7 (95% CI 1.3-2.1); post-neonatal death OR 2.1 (95% CI 1.7-2.7); and early childhood death OR 2.4 (95% CI 1.8-3.4) (Table 2). Adjustment for socio-demographic profile (Model 1) attenuated the odds for offspring of mothers with severe mental illness at all mortality ages and the OR for stillbirth was no longer significant. Adjustment for critical-severity obstetric complications (Model 2) attenuated ORs further but the pattern of risks remained the same: neonatal death OR 1.3 (95% CI 1.1-1.7); post-neonatal death OR 1.4 (95% CI 1.1-1.8); and early childhood death OR 1.8 (95% CI 1.3-2.6). There were no significant interactions between maternal severe mental illness status and offspring exposure to obstetric complications for any of the periods of premature death. Full details of the models can be found in Supplementary Tables 1A-1D.

3.4 Timing of maternal illness onset relative to index birth

Table 3 shows premature deaths in different periods by timing of maternal illness onset. Of 15,486 children born to mothers with severe mental illness, 3,194 (20.6%) were conceived after illness onset. These children had a slightly higher mortality rate than those conceived before onset of severe maternal illness (2.5% vs 2.2%).

There was little evidence of a difference in the odds ratios for children of mothers whose onset of severe mental illness was prior to the beginning of a given risk period compared to those children of mothers whose illness onset came later (Figure 1). This result held true when analyses were repeated, using time of conception as the defining cut off for all risk periods beyond stillbirth, and also when Cox regressions allowed for time at risk to be apportioned between that spent before a mother was diagnosed and that spent after maternal mental illness onset.

3.5 Cause of death

In the cohort as a whole, the majority of stillbirths and deaths during the neonatal period were attributable to potentially avoidable natural causes (64.2% and 61.8% respectively); children of mothers with severe mental illness had slightly higher percentages in this category (67.4% of stillbirths and 65.7% of neonatal deaths) than children of mothers with no mental illness (64.1% of stillbirths and 61.5% of neonatal deaths). In the post neonatal period, these same causes were attributed to a total of 19.2% of all deaths of children born to mothers with no mental illness and 6.8% of deaths of children born to mothers with severe mental illness. However, both these figures should be viewed in the context of the high proportion of deaths of indeterminate classification (45.6% and 60.8% respectively). For children aged 1-5 years, potentially avoidable external causes explained

56.5% of deaths of children born to mothers with severe mental illness and 43.1% of those born to mothers with no mental illness. See Table 4.

4. Discussion

4.1 Main findings

Children of mothers with severe mental illness had significantly elevated odds of stillbirth, neonatal, post-neonatal and early childhood death (between 1 and 5 years of age) compared to children of mothers with no recorded mental illness. Moreover, these children were more likely to be born to a mother under 20 years of age, to an indigenous mother and to have been exposed to adverse socio-demographic environments at birth. Adjustment for these factors, which are known to contribute to infant and early childhood mortality, and adjustment for having an unknown father, or a mother residing in an area of socioeconomic deprivation materially reduced the odds for premature death and the odds of stillbirth were no longer significantly elevated.

Unlike other studies, we were also able to adjust for exposure to a comprehensive range of obstetric complications and to distinguish between the severities of these. Obstetric complications had the same effect on mortality in children of mothers with severe mental illness and children of mothers with no mental illness. However, children of mothers with severe mental illness were more likely to experience obstetric complications of critical severity. Correspondingly, the odds of premature mortality attributable to maternal severe mental illness decreased by approximately 5% after taking account of both socio-demographic and obstetric environments. We note that, as offspring age increased, mortality risk attributable to maternal severe mental illness increased, while the risk attributable to obstetric complications decreased. We did not observe any effect of timing of maternal severe mental illness onset on mortality in any risk period. The most common causes of stillbirths and neonatal deaths were potentially avoidable natural causes, while the most common causes of death in children aged 1 - < 5 years were from potentially avoidable external sources. This pattern was consistent across both groups of children, with potentially avoidable causes representing slightly larger proportions of all deaths in the indicated periods for children of mothers with severe mental illness than children of mothers with no mental illness.

4.2 Strengths and Limitations

Our study design has several strengths. Our large, whole population cohort ensured adequate power for simultaneous investigation of the effects of maternal severe mental illness and comprehensive measures of exposure to obstetric complications on child mortality in discrete age bands up to five years. Access to complete population administrative registers enabled inclusion of prospectively recorded data, avoiding recall bias. Use of multiple registers allowed access to a wide range of covariates, providing robust estimates.

One limitation is a loss to follow-up of people who have moved out of the State and, hence, beyond the geographic ambit of the registers. This is especially problematic if loss through out-migration affects some groups within a population more than others. In Western Australia, the State's natural advantages in addition to a relatively thriving economy has given it one of the highest rates of Australian interstate in-migration in the past years and, combined with its geographic isolation, one of the lowest levels of out-migration. Overall, out-migration is fairly constant, and averaged 2.7% for the period 1990–2008. None of the available evidence suggests that out-migration introduces a systematic bias into the data.

Although we adjusted for a number of covariates, an important limitation is the absence of data on key maternal exposures. Thus, we lack knowledge about maternal psychotropic and other medications during pregnancy, maternal smoking, alcohol or illicit substance use during pregnancy, all of which are implicated in stillbirth and premature infant death (Salihu and Wilson, 2007; Strandberg-Larsen et al., 2009; Wolfe et al., 2005). Our classification of mothers with severe mental illness was based on a history of psychiatric contact up to the end of 2002. We expect that some comparison children born in the later years of the cohort would have mothers who went on to develop a mental illness after this time.

4.3 Comparison with previous findings.

Our results are comparable to previous findings. As death in childhood is rare, and follow up times are relatively short and equal, it is reasonable to assume that estimates reported in other literature as relative risks or odds ratios are comparable to our own ORs (Green and Symons, 1983). Our unadjusted OR of 1.2 for stillbirth is slightly lower than other reported risk estimates: 1.6 (Bennedsen et al., 2001), 1.9 (Webb et al., 2005), 1.7 (Webb et al., 2006) and 2.1 (Nilsson et al., 2002). The OR that we report of 1.7 for neonatal deaths falls within the range reported previously: 1.4 (Bennedsen et al., 2001), 1.8 (Nilsson et al., 2008) and 1.9 (Webb et al., 2006). The same is true for our post neonatal effect estimates: OR=2.1 compared with 1.5 (Webb et al., 2006), 2.8 (Bennedsen et al., 2001) and 3.5 (Nilsson et al., 2008). Webb et al (Webb et al., 2006) is the only report to examine children over one year of age and their estimate of 2.3 excess premature mortality risk agrees closely with ours (OR=2.4). The sizes of the observed differences maybe explained in part at least by differences in definitions for stillbirth and the use of a broader category of maternal severe mental illness here as opposed to maternal schizophrenia in the cited reports.

Not all these studies reported adjusted estimates but, for those that did, the reduction from unadjusted to adjusted estimates was of similar magnitude to ours.

4.4 Implications

No other studies have been able to adjust for such a comprehensive range of obstetric complications as we have done. Using a sophisticated and validated algorithm, we were able to account for a woman's entire birth-specific obstetric complication history. Each complication from the beginning of pregnancy up to the first few hours of neonatal life was assessed for its potential to meet a critical threshold for negative impact on the exposed child's developing central nervous system. This means that for the first time we have been able to parse in detail these clinically relevant components of risk in the premature mortality of children of mothers with severe mental illness.

Compared to children of mothers with no mental illness, we observed children of mothers with severe mental illness were exposed to more adverse socio-demographic environments at birth and experienced higher rates of serious obstetric complications which potentially affect the developing central nervous system. When we accounted for these 'non-psychiatric burdens', we saw considerable reductions in the differential mortality rates between the two groups. This suggests that at least some of the causes of premature mortality of children of mothers with severe mental illness are preventable. Early and attentive antenatal care is essential to minimise exposure of children to serious obstetric complications; however, women with severe mental illness are more likely to book late for antenatal care (Abel and Morgan, 2011) and less likely to give up behaviours which contribute to adverse health risks for their infants (Jablensky et al., 2005). This implies a need for more intensive outreach and education for at risk women including better reproductive health and pregnancy planning (Abel and Rees, 2010). Our findings also suggest that improvements in risk may be achieved by ensuring comprehensive social supports for Indigenous women and/or those residing in remote areas or areas of high socioeconomic disadvantage.

Our data showed that timing of maternal illness onset had little impact on mortality outcomes. With respect to stillbirths, this is in contrast to Sørensen et al, (Sorensen et al., 2015) who reported a two-fold increase in the risk of stillbirth for children of mothers exposed to antipsychotic medication during pregnancy, compared to children of mothers exposed only prior to pregnancy. While psychotropic medication use in pregnancy is an important public health concern, the evidence of its impact on fetal outcomes remains unclear (Abel, 2013), with further research required. Moreover, there are a number of other factors that may be exerting competing influences on outcomes including: reverse causality, in that the death of a child is associated with an increased incidence of mental illness in mothers for up to five years after the child's death (Li et al., 2005); behavioural risk exposures such as substance abuse before and/or after illness onset; and service-related factors where mothers diagnosed before the birth of their child may receive better care and support in their parenting role. In the absence of data on these factors in our study, we are unable to determine why we observed no differences pre- and post-maternal illness onset.

4.5 Conclusions

Our findings confirm Webb et al's previous report of premature mortality continuing beyond infancy in offspring of mothers with severe mental illness. We extend these findings by a detailed consideration of obstetric variables which have not been accounted for previously in this population. Our observations support the claim that higher premature mortality is explained substantially by adverse socio-demographic environments and critical obstetric complications. By contrast, timing of a mother's illness onset was not observed to contribute to increased premature mortality risk.

Our findings suggest that priority should be given to the prompt diagnosis of maternal mental illness along with targeted delivery of high quality antenatal, obstetric and psychiatric care; and that targeted services should be developed to support women in social disadvantage. Such supports and education should not be confined to the antenatal period but should continue postnatally for these parents as their children grow.

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Conflict of Interest

The authors report no financial relationships with commercial interests.

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Contributions

PD –drafted and managed final drafts, conducted all final analyses and prepared tables and figures

KMA – designed the study, contribution to literature searches, input to final drafts

TA – input to final drafts, conducted some interim analyses

AJ – designed the study

MC – designed the study, input to initial drafts

SS – managed initial drafts and analyses

TM – input to final drafts, OC specialist

MP – input to some interim analyses

VM – designed the study, conducted literature searches, very substantial input to all drafts

All authors contributed to and have approved the final manuscript. .

Table 1. Characteristics of children in the cohort by maternal psychotic illness category and timing of death. Number and percentage.

	Deaths												Births			
	Stillbirth		Neonatal		Post-neonatal		Early childhood 1 - <5 years		Total deaths				Total births			
	N _{died} =3,351		N _{died} =1,820		N _{died} =1,103		N _{died} =603		Children of mothers with severe mental illness		Comparison children		Children of mothers with severe mental illness		Comparison children	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Deaths													354	2.3	6,523	1.4
Exposed to obstetric complications of critical severity	3,254	97.1	1,789	98.3	939	85.1	473	78.4	333	94.1	6122	93.9	11,779	76.1	321,447	71.0
Sex																
Female	1,576	47.0	769	42.3	488	44.2	262	43.4	151	42.7	2944	45.1	7,441	48.0	220,340	48.7
Male	1,748	52.2	1,051	57.7	615	55.8	341	56.6	202	57.1	3553	54.5	8,044	51.9	232,093	51.3
Missing															26	0.0
Mother's age ^a																
<20 years	269	8.0	185	10.2	142	12.9	72	11.9	47	13.3	621	9.5	1,574	10.2	24,674	5.5
20-34 years	2,638	78.7	1,427	78.4	892	80.9	477	79.1	275	77.7	5159	79.1	12,446	80.4	379,686	83.9
>35 years	444	13.2	208	11.4	69	6.3	54	9.0	32	9.0	743	11.4	1,466	9.5	48,083	10.6
Missing															16	0.0
Father's age ^a																
<20 years	52	1.6	36	2.0	26	2.4	15	2.5	11	3.1	118	1.8	368	2.4	6,237	1.4
20-34 years	2,041	60.9	1,161	63.8	720	65.3	393	65.2	199	56.2	4116	63.1	10,218	66.0	320,227	70.8
>35 years	837	25.0	419	23.0	167	15.1	108	17.9	57	16.1	1474	22.6	3,090	20.0	106,324	23.5
Missing	362	10.8	196	10.8	173	15.7	75	12.4	77	21.8	729	11.2	1,612	10.4	16,546	3.7

	Deaths												Births			
	Stillbirth		Neonatal		Post-neonatal		Early childhood 1 - <5 years		Total deaths				Total births			
									Children of mothers with severe mental illness		Comparison children		Children of mothers with severe mental illness		Comparison children	
	N _{died} =3,351		N _{died} =1,820		N _{died} =1,103		N _{died} =603		N _{died} =354		N _{died} =6,523		N=15,486		N=452,459	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Father unknown	59	1.8	8	0.4	17	1.5	12	2.0	10	2.8	86	1.3	198	1.3	3125	0.7
Parity																
0	1,467	43.8	773	42.5	335	30.4	214	35.5	136	38.4	2653	40.7	5,625	36.3	180,521	39.9
1	913	27.2	498	27.4	344	31.2	171	28.4	89	25.1	1837	28.2	4,800	31.0	151,389	33.5
2	545	16.3	297	16.3	217	19.7	115	19.1	66	18.6	1108	17.0	2,834	18.3	76,795	17.0
3+	414	12.4	242	13.3	204	18.5	100	16.6	62	17.5	898	13.8	2,173	14.0	42,189	9.3
Missing													54	0.3	1,565	0.3
Maternal marital status ^a																
Partnered	2,891	86.3	1,562	85.8	876	79.4	499	82.8	246	69.5	5582	85.6	12,415	80.2	413,111	91.3
Single or other	458	13.7	257	14.1	227	20.6	104	17.2	108	30.5	938	14.4	3,047	19.7	39,109	8.6
Missing													24	0.2	239	0.1
Socioeconomic index maternal residence ^a																
Lowest quintile (most disadvantaged)	806	24.1	449	24.7	347	31.5	172	28.5	118	33.3	1656	25.4	4,368	28.2	86,872	19.2
Second	733	21.9	414	22.7	248	22.5	140	23.2	97	27.4	1438	22.0	3,836	24.8	99,757	22.0
Third	670	20.0	343	18.8	222	20.1	115	19.1	70	19.8	1280	19.6	2,894	18.7	88,034	19.5
Fourth	540	16.1	299	16.4	144	13.1	91	15.1	39	11.0	1035	15.9	2,328	15.0	81,805	18.1
Highest quintile (least disadvantaged)	558	16.7	299	16.4	137	12.4	82	13.6	25	7.1	1051	16.1	1,982	12.8	93,081	20.6

	Deaths												Births			
	Stillbirth		Neonatal		Post-neonatal		Early childhood 1 - <5 years		Total deaths				Total births			
	N _{died} =3,351		N _{died} =1,820		N _{died} =1,103		N _{died} =603		Children of mothers with severe mental illness N _{died} =354		Comparison children N _{died} =6,523		Children of mothers with severe mental illness N=15,486		Comparison children N=452,459	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Unknown													78	0.5	2,910	0.6
Maternal residence ^a																
Major cities	2,102	62.7	1,109	60.9	598	54.2	316	52.4	191	54.0	3,934	60.3	9,073	58.6	301,557	66.6
Inner regional	317	9.5	179	9.8	90	8.2	70	11.6	36	10.2	620	9.5	1,640	10.6	43,727	9.7
Outer regional	418	12.5	228	12.5	176	16.0	89	14.8	65	18.4	846	13.0	2,578	16.6	53,978	11.9
Remote	288	8.6	165	9.1	120	10.9	56	9.3	31	8.8	598	9.2	1,476	9.5	34,655	7.7
Very remote	226	6.7	136	7.5	119	10.8	72	11.9	31	8.8	522	8.0	718	4.6	18,361	4.1
Missing															181	0.0
Mother's Indigenous status																
Aboriginal or Torres Strait Islander	412	12.3	259	14.2	261	23.7	122	20.2	103	29.1	951	14.6	2,290	14.8	27,984	6.2
Father's mental health status																
Father with no mental health contact	2,880	85.9	1,580	86.8	925	83.9	491	81.4	264	74.6	5,612	86.0	11,689	75.5	399,203	88.2
Father with any mental health contact other than psychosis	356	10.6	201	11.0	135	12.2	81	13.4	71	20.1	702	10.8	2,827	18.3	43,068	9.8
Father with any psychosis	56	1.7	31	1.7	26	2.4	19	3.2	9	2.5	123	1.9	772	5.0	7,063	1.7

^a At child's birth.

Table 2. Mortality by timing of death, maternal psychotic illness and exposure to obstetric complications. Unadjusted and adjusted^a odds ratio and 95% confidence intervals.

	Unadjusted			Model 1			Model 2		
	OR	95lo	95hi	OR	95lo	95hi	OR	95lo	95hi
Stillbirth									
Maternal psychotic illness									
Children of mothers with severe mental illness	1.2	1.0 ^b	1.5	1.1	0.9	1.3			^c
Comparison children	Ref			Ref					
Neonatal death									
Maternal psychotic illness									
Children of mothers with severe mental illness	1.7	1.3	2.1	1.4	1.1	1.8	1.3	1.1	1.7
Comparison children	Ref			Ref			Ref		
Obstetric complications									
Exposed to at least 1 complication of critical severity							23.8	16.6	33.9
Not exposed to any complications of critical severity							Ref		
Post-neonatal death									
Maternal psychotic illness									
Children of mothers with severe mental illness	2.1	1.7	2.7	1.5	1.2	1.9	1.4	1.1	1.8
Comparison children	Ref			Ref			Ref		
Obstetric complications									
Exposed to at least 1 complication of critical severity							2.5	2.1	2.9
Not exposed to any complications of critical severity							Ref		
Childhood death 1 year - <5 years									
Maternal psychotic illness									
Children of mothers with severe mental illness	2.4	1.8	3.4	1.9	1.4	2.6	1.8	1.3	2.6
Comparison children	Ref			Ref			Ref		
Obstetric complications									
Exposed to at least 1 complication of critical severity							1.5	1.2	1.8
Not exposed to any complications of critical severity							Ref		

^a Odds ratios in Model 1 adjusted simultaneously for demographic and socioeconomic covariates: sex, parents' ages, birth order, mother's marital status, area level socioeconomic and remoteness measures and indigenous status, father's psychiatric morbidity status and year of birth and further adjusted in Model 2 for exposure to obstetric complications

^b Listed boundary of odds ratio does not contain 1, but is recorded as 1.0 when rounded to 1 decimal place.

^c Model 2 is not reported for stillbirths as every stillbirth to a mother with severe mental illness was preceded by exposure to at least 1 obstetric complication of critical severity

Table 3. Mortality by timing of death, maternal severe mental illness and timing of onset of maternal severe mental illness. Number and percentage.

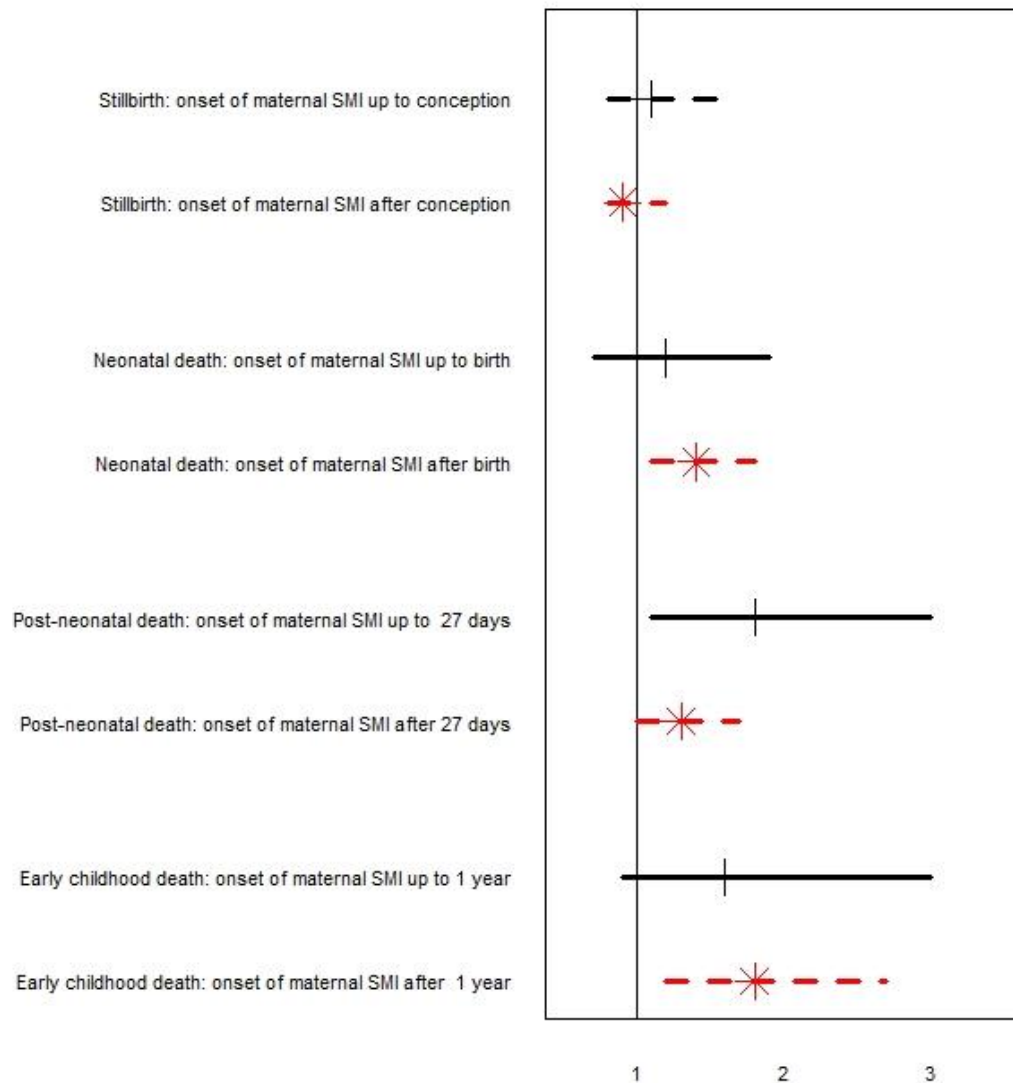
		Children of mothers with severe mental illness Total births = 15,486								Comparison children Total births=452,459			
		Onset of maternal severe mental illness before start of mortality risk period											
		Yes				No							
		Child died during period				Child died during period				Child died during period			
		Yes		No		Yes		No		Yes		No	
Mortality risk period	Start of mortality risk period	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
All deaths < 5 years	Date of conception	79	2.5	3,115	97.5	275	2.2	12,017	97.8	6,523	1.4	445,936	98.6
Stillbirth	Date of conception	32	1.0	3,162	99.0	103	0.8	12,189	99.2	3,216	0.7	449,243	99.3
Neonatal	Date of birth	17	0.5	3,547	99.5	82	0.7	11,705	99.3	1,721	0.4	447,522	99.6
Post-neonatal	28 days	19	0.5	3,668	99.5	55	0.5	11,510	99.5	1,029	0.2	446,493	99.8
Early childhood	1 year	11	0.2	4,769	99.8	35	0.3	10,363	99.7	557	0.1	445,936	99.9

Table 4. Mortality by timing and cause of death. Number ^a and percentage.

Timing and cause of death	Children of mothers with severe mental illness		Comparison children		Total	
		(%)		(%)	N	(%)
Stillbirth						
Natural causes - potentially avoidable		67.4		64.1	2152	64.2
Natural causes - other		14.1		15.6	521	15.6
External causes - potentially avoidable		0.0		0.1	<5	0.1
Other, cause ill-defined, cause unknown or no cause recorded		18.5		20.2	674	20.1
Total		100		100	3351	100
Neonatal death						
Natural causes - potentially avoidable		65.7		61.5	1124	61.8
Natural causes - other		27.3		35.8	643	35.3
External causes - potentially avoidable		1.0		0.4	7	0.4
Other, cause ill-defined, cause unknown or no cause recorded		6.1		2.3	46	2.5
Total		100		100	1820	100
Post-neonatal deaths						
Natural causes - potentially avoidable		6.8		19.2	203	18.4
Natural causes - other		31.1		29.8	330	29.9
External causes - potentially avoidable		1.4		5.3	56	5.1
Other, cause ill-defined, cause unknown or no cause recorded		60.8		45.6	514	46.6
Total		100		100	1103	100
Early childhood death 1 year - < 5 years						
Natural causes - potentially avoidable		10.9		9.5	58	9.6
Natural causes - other		23.9		42.7	249	41.3
External causes - potentially avoidable		56.5		43.1	266	44.1
Other, cause ill-defined, cause unknown or no cause recorded		8.7		4.7	30	5.0
Total		100		100	603	100
		N		(%)	N	(%)
All deaths < 5 years						
Natural causes - potentially avoidable	166	46.9	3371	51.7	3537	51.4
Natural causes - other	80	22.6	1663	25.5	1743	25.4
External causes - potentially avoidable	28	7.9	305	4.7	333	4.8
Other, cause ill-defined, cause unknown or no cause recorded	80	22.6	1184	18.2	1264	18.4
Total	354	100	6523	100	6877	100

^a Ns have only been reported in marginal totals as a disclosure control method of maintaining data privacy

Figure 1. Mortality in children of mothers with severe mental illness (SMI) by timing of onset of maternal severe mental illness. Odds ratio^a, 95% confidence interval



^a Odds ratios are relative to comparison children and adjusted simultaneously for exposure to obstetric complications and demographic and socio economic covariates: year of birth, sex, parents' ages, birth order, mother's marital status, area level socioeconomic and remoteness measures and indigenous status, father's psychiatric morbidity status.

Supplementary Table 1a. Stillbirth by maternal psychotic illness category, exposure to obstetric complications and socio-demographic covariates. Unadjusted and adjusted^a odds ratio and 95% confidence intervals.

STILLBIRTH	Unadjusted			Model 1			Model 2		
	OR	95lo	95hi	OR	95lo	95hi	OR	95lo	95hi
Maternal psychotic illness									
Children of mothers with severe mental illness	1.2	1	1.5	1.2	1	1.5	1	0.8	1.2
Comparison children	Ref			Ref			Ref		
Obstetric complications of critical severity	13.7	11.2	16.8				13.2	10.8	16.2
Sex									
Male	1.1	1	1.1	1	0.9	1.3	1	1	1.1
Mother's age ^b									
<20 years	1.5	1.3	1.7	0.9	0.8	1.1	1	0.8	1.1
20 – 34 years	Ref			Ref			Ref		
>=35 years	1.3	1.2	1.5	1.3	1.2	1.5	1.2	1.1	1.4
Father's age ^b									
<20 years	1.3	1	1.7	1.2	0.8	1.6	1.2	0.9	1.6
20 – 34 years	Ref			Ref			Ref		
>=35 years	1.2	1.1	1.3	1.2	1.1	1.3	1.2	1.1	1.3
Unknown age	3.3	2.9	3.7	2.9	2.4	3.5	2.8	2.3	3.3
Father unknown	2.9	2.2	3.8	2.3	1.7	3.2	2.2	1.6	3.1
Parity									
0	Ref			Ref			Ref		
1	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.8	0.9
2	0.9	0.8	1	0.8	0.7	0.9	0.9	0.9	1.1
3+	1.2	1.1	1.3	0.9	0.8	1.1	1.1	1	1.3
unknown	1	0.6	1.8	0.9	0.5	1.5	1	0.6	1.7
Maternal marital status ^b									
Married or <i>de facto</i>	Ref			Ref			Ref		
Single or other	1.6	1.4	1.8	0.9	0.8	1	0.9	0.8	1
Unknown	1.1	0.3	4.5	0.7	0.2	2.9	0.7	0.2	2.8
Socioeconomic index maternal residence ^b									
Lowest quintile (most disadvantaged)	1.5	1.3	1.7	1.3	1.1	1.4	1.2	1.1	1.4
Second	1.2	1.1	1.4	1.2	1	1.3	1.1	1	1.3
Third	1.3	1.1	1.4	1.2	1.1	1.4	1.2	1.1	1.4
Fourth	1.1	1	1.2	1.1	1	1.3	1.1	1	1.2
Highest quintile (least disadvantaged)	Ref			Ref			Ref		
Missing	2.5	1.9	3.5	2.4	1.8	3.4	2.4	1.7	3.3
Maternal residence ^b									
Major cities	Ref			Ref			Ref		
Inner regional	1	0.9	1.2	1	0.9	1.2	1	0.9	1.2
Outer regional	1.1	1	1.2	1	0.9	1.2	1.1	0.9	1.2
Remote	1.2	1	1.3	1	0.9	1.2	1	0.9	1.2
Very remote	1.8	1.5	2	1.1	1	1.3	1.1	1	1.4
Missing									
Mother's Indigenous status									
Aboriginal or Torres Strait Islander	2	1.8	2.3	1.4	1.2	1.6	1.3	1.1	1.5
Not Aboriginal or Torres Strait Islander	Ref			Ref			Ref		
Father's psychiatric morbidity status									
Father with any psychosis diagnosis	1	0.8	1.3	1.1	0.8	1.4	1	0.8	1.4
Father with any mental health contact other than psychosis	1.1	1	1.2	1.2	1	1.3	1.1	1	1.3
Father with no mental health contact	Ref			Ref			Ref		

^a Odds ratios in Model 1 adjusted simultaneously for demographic and socioeconomic covariates: sex, parents' ages, birth order, mother's marital status, area level socioeconomic and remoteness measures and indigenous status, father's psychiatric morbidity status and year of birth and further adjusted in Model 2 for exposure to obstetric complications.

^b At child's birth

Supplementary Table 1b. Neonatal death by maternal psychotic illness category, exposure to obstetric complications and socio-demographic covariates. Unadjusted and adjusted^a odds ratio and 95% confidence intervals.

NEONATAL DEATH	Unadjusted			Model 1			Model 2		
	OR	95lo	95hi	OR	95lo	95hi	OR	95lo	95hi
Maternal psychotic illness									
Children of mothers with severe mental illness	1.7	1.3	2.1	1.4	1.1	1.8	1.3	1.1	1.7
Comparison children	Ref			Ref			Ref		
Obstetric complications of critical severity	23.7	16.6	33.8				23.7	16.6	33.9
Sex									
Male	1.3	1.2	1.4	1.3	1.2	1.4	1.3	1.1	1.4
Mother's age ^b									
<20 years	2	1.7	2.3	1.3	1	1.6	1.3	1.1	1.6
20 – 34 years	Ref			Ref			Ref		
>=35 years	1.2	1	1.4	1.2	1	1.5	1.1	1	1.4
Father's age ^b									
<20 years	1.6	1.1	2.2	1.1	0.7	1.6	1.1	0.7	1.6
20 – 34 years	Ref			Ref			Ref		
>=35 years	1.1	1	1.2	1.2	1	1.3	1.1	1	1.3
Unknown age	3.1	2.7	3.7	2.1	1.7	2.7	2	1.6	2.6
Father unknown	0.7	0.3	1.4	0.5	0.2	1	0.5	0.2	0.9
Parity									
0	Ref			Ref			Ref		
1	0.8	0.7	0.9	0.8	0.7	0.9	0.9	0.8	1
2	0.9	0.8	1	0.9	0.8	1	1	0.9	1.2
3+	1.3	1.1	1.5	1.1	0.9	1.3	1.3	1.1	1.6
unknown	1.3	0.7	2.6	0.8	0.4	1.6	0.9	0.5	1.8
Maternal marital status ^b									
Married or <i>de facto</i>	Ref			Ref			Ref		
Single or other	1.7	1.5	1.9	0.9	0.8	1.2	0.9	0.8	1.1
Unknown	1	0.1	7.4	0.9	0.1	6.7	0.9	0.1	6.4
Socioeconomic index maternal residence ^b									
Lowest quintile (most disadvantaged)	1.6	1.3	1.8	1.3	1.1	1.5	1.2	1	1.5
Second	1.3	1.1	1.5	1.2	1	1.4	1.2	1	1.4
Third	1.2	1	1.4	1.2	1	1.4	1.2	1	1.4
Fourth	1.1	1	1.3	1.2	1	1.4	1.2	1	1.4
Highest quintile (least disadvantaged)	Ref			Ref			Ref		
Missing	1.7	1	2.9	1.3	0.8	2.3	1.3	0.8	2.2
Maternal residence ^b									
Major cities	Ref			Ref			Ref		
Inner regional	1.1	0.9	1.3	1.1	0.9	1.3	1.1	0.9	1.3
Outer regional	1.1	1	1.3	1	0.9	1.2	1	0.9	1.2
Remote	1.3	1.1	1.5	1	0.9	1.2	1.1	0.9	1.3
Very remote	2	1.7	2.4	1.2	1	1.5	1.2	1	1.5
Missing	4.6	1.5	14.4	3.8	1.1	12.6	4	1.2	13.2
Mother's Indigenous status									
Aboriginal or Torres Strait Islander	2.4	2.1	2.8	1.8	1.5	2.1	1.7	1.4	2
Not Aboriginal or Torres Strait Islander	Ref			Ref			Ref		
Father's psychiatric morbidity status									
Father with any psychosis diagnosis	1	0.7	1.5	1	0.7	1.5	1	0.7	1.4
Father with any mental health contact other than psychosis	1.1	1	1.3	1.1	0.9	1.3	1.1	0.9	1.3
Father with no mental health contact	Ref			Ref			Ref		

^a Odds ratios in Model 1 adjusted simultaneously for demographic and socioeconomic covariates: sex, parents' ages, birth order, mother's marital status, area level socioeconomic and remoteness measures and indigenous status, father's psychiatric morbidity status and year of birth and further adjusted in Model 2 for exposure to obstetric complications.

^b At child's birth

Supplementary Table 1c. Post-neonatal death by maternal psychotic illness category, exposure to obstetric complications and socio-demographic covariates. Unadjusted and adjusted^a odds ratio and 95% confidence intervals.

POST-NEONATAL DEATH	Unadjusted			Model 1			Model 2		
	OR	95lo	95hi	OR	95lo	95hi	OR	95lo	95hi
Maternal psychotic illness									
Children of mothers with severe mental illness	2.1	1.7	2.7	1.5	1.1	1.9	1.4	1.1	1.8
Comparison children	Ref			Ref			Ref		
Obstetric complications of critical severity	2.4	2	2.8				2.5	2.1	2.9
Sex									
Male	1.2	1.1	1.3	1.2	1.1	1.4	1.2	1.1	1.3
Mother's age ^b									
<20 years	2.4	2	2.9	1.5	1.2	1.9	1.5	1.2	1.9
20 – 34 years	Ref			Ref			Ref		
>=35 years	0.6	0.5	0.8	0.7	0.5	0.9	0.7	0.5	0.9
Father's age ^b									
<20 years	1.8	1.2	2.7	1.1	0.7	1.7	1.1	0.7	1.7
20 – 34 years	Ref			Ref			Ref		
>=35 years	0.7	0.6	0.8	0.8	0.7	0.9	0.8	0.7	0.9
Unknown age	4.5	3.8	5.3	2.2	1.7	2.8	2.1	1.6	2.7
Father unknown	2.4	1.4	4	0.9	0.5	1.6	0.9	0.5	1.6
Parity									
0	Ref			Ref			Ref		
1	1.2	1	1.4	1.5	1.3	1.7	1.6	1.3	1.8
2	1.5	1.3	1.8	1.8	1.5	2.2	1.9	1.6	2.3
3+	2.6	2.1	3	2.6	2.2	3.2	2.9	2.3	3.5
unknown	1.4	0.5	3.7	1	0.4	2.7	1	0.4	2.8
Maternal marital status ^b									
Married or <i>de facto</i>	Ref			Ref			Ref		
Single or other	2.6	2.3	3.1	1.3	1.1	1.7	1.3	1.1	1.7
Unknown									
Socioeconomic index maternal residence ^b									
Lowest quintile (most disadvantaged)	2.7	2.2	3.2	1.5	1.2	1.8	1.5	1.2	1.8
Second	1.7	1.3	2.1	1.3	1	1.6	1.3	1	1.6
Third	1.7	1.4	2.1	1.5	1.2	1.8	1.4	1.2	1.8
Fourth	1.2	0.9	1.5	1.1	0.9	1.4	1.1	0.9	1.4
Highest quintile (least disadvantaged)	Ref			Ref			Ref		
Missing	1.2	0.5	2.9	0.8	0.3	2	0.8	0.3	2
Maternal residence ^b									
Major cities	Ref			Ref			Ref		
Inner regional	1	0.8	1.3	0.9	0.7	1.2	0.9	0.7	1.2
Outer regional	1.6	1.4	1.9	1.3	1.1	1.5	1.3	1.1	1.5
Remote	1.7	1.4	2.1	1.2	0.9	1.4	1.2	1	1.5
Very remote	3.3	2.7	4	1.3	1.1	1.7	1.4	1.1	1.7
Missing									
Mother's Indigenous status									
Aboriginal or Torres Strait Islander	4.6	4	5.3	2.1	1.7	2.5	2	1.7	2.5
Not Aboriginal or Torres Strait Islander	Ref			Ref			Ref		
Father's psychiatric morbidity status									
Father with any psychosis diagnosis	1.5	1	2.2	1.4	0.9	2	1.4	0.9	2
Father with any mental health contact other than psychosis	1.3	1.1	1.6	1.2	1	1.4	1.2	1	1.4
Father with no mental health contact	Ref			Ref			Ref		

^a Odds ratios in Model 1 adjusted simultaneously for demographic and socioeconomic covariates: sex, parents' ages, birth order, mother's marital status, area level socioeconomic and remoteness measures and indigenous status, father's psychiatric morbidity status and year of birth and further adjusted in Model 2 for exposure to obstetric complications.

^b At child's birth

Supplementary Table 1d. Early childhood death 1 year - <5 years by maternal psychotic illness category, exposure to obstetric complications and socio-demographic covariates. Unadjusted and adjusted^a odds ratio and 95% confidence intervals.

EARLY CHILDHOOD DEATH 1 - <5 YRS	Unadjusted			Model 1			Model 2		
	OR	95lo	95hi	OR	95lo	95hi	OR	95lo	95hi
Maternal psychotic illness									
Children of mothers with severe mental illness	2.4	1.8	3.4	1.8	1.3	2.5	1.8	1.3	2.5
Comparison children	Ref			Ref			Ref		
Obstetric complications of critical severity	1.5	1.2	1.8				1.5	1.2	1.8
Sex									
Male	1.2	1.1	1.5	1.2	1.1	1.5	1.2	1	1.4
Mother's age ^b									
<20 years	2.3	1.8	2.9	1.4	1	1.8	1.4	1	1.8
20 – 34 years	Ref			Ref			Ref		
>=35 years	0.9	0.7	1.2	1	0.7	1.4	1	0.7	1.4
Father's age ^b									
<20 years	1.9	1.1	3.2	1.2	0.7	2.1	1.2	0.7	2.1
20 – 34 years	Ref			Ref			Ref		
>=35 years	0.8	0.7	1	0.9	0.7	1.1	0.9	0.7	1.1
Unknown age	3.6	2.8	4.6	2	1.4	2.8	1.9	1.4	2.7
Father unknown	3.1	1.7	5.5	1.4	0.8	2.7	1.4	0.8	2.6
Parity									
0	Ref			Ref			Ref		
1	0.9	0.8	1.2	1.1	0.9	1.3	1.1	0.9	1.4
2	1.3	1	1.6	1.4	1.1	1.7	1.4	1.1	1.8
3+	2	1.6	2.5	1.8	1.3	2.4	1.9	1.4	2.5
unknown	1.6	0.5	5.1	1.1	0.4	3.6	1.2	0.4	3.7
Maternal marital status ^b									
Married or <i>de facto</i>	Ref			Ref			Ref		
Single or other	2.1	1.7	2.6	1.1	0.9	1.5	1.1	0.9	1.5
Unknown									
Socioeconomic index maternal residence ^b									
Lowest quintile (most disadvantaged)	2.2	1.7	2.9	1.3	0.9	1.7	1.3	0.9	1.7
Second	1.6	1.2	2.1	1.2	0.9	1.6	1.2	0.9	1.6
Third	1.5	1.1	2	1.2	0.9	1.7	1.2	0.9	1.7
Fourth	1.3	0.9	1.7	1.2	0.9	1.6	1.2	0.9	1.6
Highest quintile (least disadvantaged)	Ref			Ref			Ref		
Missing	1.2	0.4	3.7	0.8	0.3	2.6	0.8	0.3	2.6
Maternal residence ^b									
Major cities	Ref			Ref			Ref		
Inner regional	1.5	1.2	2	1.4	1.1	1.8	1.4	1.1	1.8
Outer regional	1.6	1.2	2	1.3	1	1.7	1.3	1	1.7
Remote	1.5	1.1	2	1.1	0.9	1.5	1.2	0.9	1.5
Very remote	3.8	2.9	4.9	2	1.5	2.6	2	1.5	2.6
Missing									
Mother's Indigenous status									
Aboriginal or Torres Strait Islander	3.7	3.1	4.6	1.8	1.4	2.4	1.8	1.4	2.3
Not Aboriginal or Torres Strait Islander	Ref			Ref			Ref		
Father's psychiatric morbidity status									
Father with any psychosis diagnosis	2	1.3	3.2	1.9	1.2	2.9	1.8	1.2	2.9
Father with any mental health contact other than psychosis	1.5	1.2	1.9	1.4	1.1	1.8	1.4	1.1	1.7
Father with no mental health contact	Ref			Ref			Ref		

^a Odds ratios in Model 1 adjusted simultaneously for demographic and socioeconomic covariates: sex, parents' ages, birth order, mother's marital status, area level socioeconomic and remoteness measures and indigenous status, father's psychiatric morbidity status and year of birth and further adjusted in Model 2 for exposure to obstetric complications.

^b At child's birth

Supplementary Table 2. Cause of death classifications

Natural causes – potentially avoidable

ICD-10 codes: A38-A41, A46, A481, G00, G03, J02.0, J13-J16, J18, L03, J10-J12, B20-B24, C18-C21, C43-C44, C50, C53, C61, C64, C73, C81, C91.0, E10-E14, I00-I09, I33-I37, I10-I13, I20-I25, I60-I69, I50, I51.1,.2,.4,.5, I26, N17-N19, J40-J44, J45-J46, K25-K27, P, O,

ICD-9 codes: 034-036, 038, 042, 153-154, 172-175, 180, 185, 189.0, 193, 201, 204, 250, 320, 322, 390-398, 421, 424, 401-404, 410-415, 429, 430-434, 436-438, 428, 429.0,.1,.5,.6, 462, 480-483, 485-487, 490-492, 496, 493, 514, 531, 532, 533, 584-586, 630-679, 681-682, 760-779

External causes– potentially avoidable

ICD-10 codes: W00-W19, X00-X09, X60-X84, Y87.0, Y60-Y69, Y70-Y82, Y83-84, V01-V99, W20-W49, W50-W64, W65-W74, W75-W84, W85-W99, X10-X19, X20-X29, X30-X39, X40-X49, X50-X57, X58-X59, X85-Y09, Y10-Y34, Y35-Y36, Y40-Y59, Y85-Y86, Y87.1-Y89.9

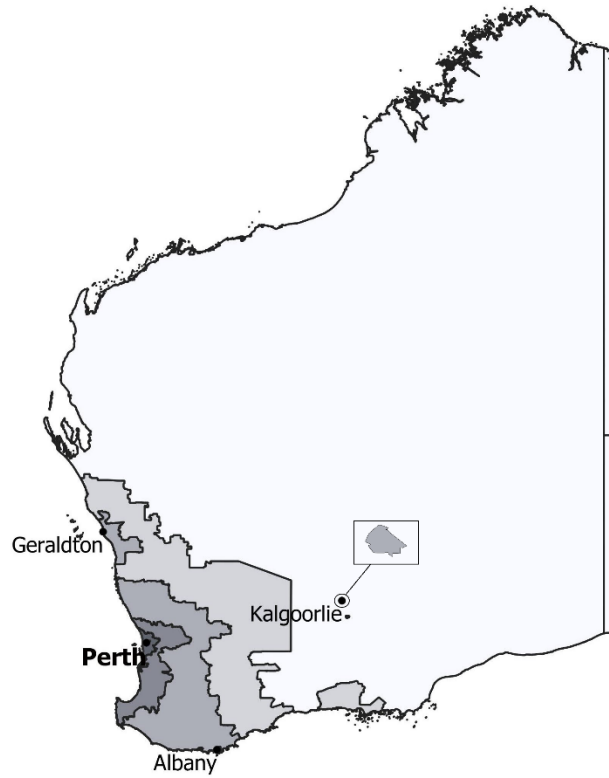
ICD-9 codes: E800-E851, E855, E858.8, E860.9, E863.9, E866.9, E869.9, E870-E876, E878-E879.7, E880-E888, E890-E899, E900-E901, E902.8, E903- E960.0, E968.9, E969 -E978, E980, E982.8, E983.8, E984-E986, E987.9, E988 E989, E991.2, E92-E996, E997.1, E997.8, E998, E999

Unknown or ill-defined causes

ICD-10 codes: R95, R98, R99

ICD-9 codes: 799.9, 798.0, .9

Supplementary Figure 1. Remoteness Area categories of Western Australia



Remoteness Areas as defined by the Australian Bureau of Statistics, 2016

- Major Cities of Australia
- Inner Regional Australia
- Outer Regional Australia
- Remote Australia
- Very Remote Australia

Supplementary Figure 2. Flow chart of loss of children from the cohort due to death

