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# BMJ Open

## Trends in mental health prevalence among mothers of Aboriginal children, 1990-2013.

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# Trends in mental health prevalence among mothers of Aboriginal children, 1990-2013.

Fernando Lima<sup>1</sup>, Carrington CJ Shepherd<sup>2</sup>, Janice Wong<sup>3</sup>, Melissa O'Donnell<sup>4</sup>, Rhonda Marriott<sup>5</sup>.

## Affiliations:

<sup>1</sup>Telethon Kids Institute, Perth, WA, Australia.

<sup>2</sup>Telethon Kids Institute. The University of Western Australia, Perth, Australia.

<sup>3</sup>Telethon Kids Institute. The University of Western Australia. Department of Health Western Australia, Perth, Australia.

<sup>4</sup> Telethon Kids Institute. The University of Western Australia, Perth, Australia.

<sup>5</sup>Murdoch University, Research Centre for Aboriginal Health & Social Equity, Perth, WA, Australia.

**Address correspondence to:** Fernando Lima, Telethon Kids Institute, Linked Analytics and Social Policy. Northern Entrance, Perth Children's Hospital, 15 Hospital Avenue, Nedlands, WA, AUS 6009. Email: fernando.lima@telethonkids.org.au

## Abstract

**Objective** This study examines the scale of maternal mental health problems among Australian Aboriginal children over time, and associations with geographical remoteness and maternal age.

**Design** A retrospective cohort study of the prevalence of maternal mental health problems among Aboriginal children born in Western Australia between 1990 and 2013.

**Setting** Population of Western Australia. Used de-identified linked administrative data from the Western Australian Department of Health.

**Participants** All Aboriginal children born in Western Australia between 1990 and 2013 and their mothers.

**Primary outcome measure** Prevalence of maternal mental health problems among Aboriginal children born between 1990 and 2013. Maternal mental health disorders were identified using mental health-related inpatient hospitalisations and mental health related outpatient contacts.

**Results** Almost 30% of cohort children were born to a mother with at least one mental health contact in the 5 years prior to birth, with 15% reported in both the year prior and year post birth. There was a distinct increase in the prevalence of maternal mental health problems between 1990 and 2013 (4-5% per year, with a peak in 2007). Maternal mental health problems were associated with living in more disadvantaged areas and Major Cities, and having a mother aged over 20 years at birth.

**Conclusions** The study affirms that mental health problems place a considerable burden on Aboriginal Australia, and suggests that many of the mental health problems that women develop earlier in life are chronic at the time of conception, during pregnancy and at birth. Early intervention and support for women in the earliest stages of family planning are required to alleviate the burden of mental health problems at and after birth. There is a clear need for policies directed to the development of a holistic health care model, with a multisector approach, offering culturally appropriate services for Aboriginal people.

**Keywords:** Maternal health; Aboriginal; Indigenous; mental health; linked administrative data; hospitalisations.

## Strength and limitations of the study

- This study used de-identified administrative linked data from the Western Australian Department of Health. This powerful resource gives researchers access to population data, both large in scale and time period covered, not previously feasible through survey methods.
- By analysing data on the prevalence of mental health problems in Aboriginal parents, the study filled a gap in the existing literature.
- Three different follow-up periods were examined which provides a perspective on maternal mental health prevalence in the sensitive periods of child development spanning pre-conception to infancy.
- This study was unable to capture people with mental health issues that have not been diagnosed or are not receiving assistance for their condition. For example, those living in rural and remote areas, where there may be limited or no access to mental health services.
- Information on mental health consultations with GPs or private clinics was not available.

## Background

Mental health issues affect almost half of the Australian population at some point during their lifetime (ABS, 2008). The impact of mental health issues not only affects the person experiencing it but also those around them, with an extensive literature showing that parental mental illness can impact upon children and their outcomes (Huntsman, 2008; Manning & Gregoire, 2009). It is estimated that between 21% and 23% of children living in an Australian household have at least one parent with a mental illness (DoHWA, 2015). Recent research has also highlighted a steady increase in children born to a mother with a mental health problem in the year before birth—at 27 per 1000 births (O'Donnell et al, 2013).

Mental health issues are a considerable burden for the Aboriginal population, with rates of suicide deaths, hospitalisation for intentional self-harm and high psychological distress reported at 2-3 times higher than for other Australians (AIHW, 2014; AIHW, 2017). These inequalities have, at least in part, been attributed to the unique post-colonisation history of Aboriginal Australia and the associated trauma of persistent discrimination, marginalisation, exclusion and dispossession (Shepherd et al., 2012; Twizeyemariya et al., 2017). Past policies and practices of forced removal of Aboriginal children from family and kinship networks has had a significant impact and resulted in adverse consequences on mental health and social and emotional wellbeing (Huntsman, 2008).

The mechanisms by which parental mental health impacts on children are complex and multifaceted. They include direct mechanisms, such as genetic inheritance, intrauterine and antenatal exposure to stress, anxiety and depression, and disrupted attachment formation between the parent and infant which can affect emotional, social, and cognitive development (Manning & Gregoire, 2009). In addition, socioeconomic disadvantage, marital discord and substance use have all been described as posing a risk to child mental health, via indirect mechanisms (Manning & Gregoire, 2009). Previous research has identified the main mental health problems affecting parenting are depression, bipolar disorder, schizophrenia, borderline personality disorder, post-traumatic stress disorder, and antisocial personality disorder (Bromfield et al., 2010).

During adolescence, children of parents with mental illness may become carers of their own parents, which can influence their emotional and social growth (Huntsman, 2008) and potentially lead to the

1  
2  
3 development of mental health issues later in their life. This negative outcome can impact children's  
4 own educational and employment outcomes leading to intergenerational disadvantage. Given the  
5 disproportionate burden of disadvantage among Aboriginal Australians, improving social and  
6 psychological conditions has the potential to reduce inequalities within Aboriginal populations that  
7 stretch across generations (Shepherd et al., 2012).  
8

9  
10 There is a lack of data on the prevalence of mental health problems in Aboriginal parents in  
11 Australia, reflecting, in part, the limitations of available population data. This study makes use of  
12 administrative data from hospitals and mental health clinics to address this information gap. We  
13 focus on mothers of Aboriginal children and hypothesise that the rate of mental health problems, as  
14 measured by event data, has increased over time and will vary by geographical remoteness and  
15 maternal age.  
16

## 17 **1. Methods**

### 18 1.1. Data source

19  
20 This study used de-identified linked administrative data from the Western Australian Department of  
21 Health. This included the Hospital Morbidity Data Collection (HMDC) (1970-current), Mental Health  
22 Information System (MHIS) (1966-current), Midwives Notification System (MNS) (1980-current) and  
23 Birth Register (BR) (1974-current). The datasets were linked by the Western Australian Data Linkage  
24 Branch (WADLB) using probabilistic matching and a robust and internationally accepted privacy  
25 preserving protocol (Holman et al. 1999). Only a unique identifier on the individual's clinical  
26 information was provided to the researchers, and any identifying information was removed.  
27  
28

### 29 1.2. Study design and statistical analysis

30 This is a retrospective cohort study of the prevalence of maternal mental health problems among  
31 Aboriginal children born in Western Australia between 1990 and 2013, inclusive. STROBE cohort  
32 reporting guidelines were utilised (von Elm et al., 2014).  
33

34 Births were identified from the MNS and Birth Registrations. Indigenous status was identified using  
35 WADLB's Derived Indigenous Status Flag, developed in conjunction with the "Getting Our Story  
36 Right" indigenous identification project by Christensen et al. (Christensen et al, 2014). This indicator  
37 uses a multi-stage median approach across a wide range of datasets to produce a single indicator of  
38 Indigenous status for each individual and is considered an optimal approach to identifying Aboriginal  
39 persons in administrative datasets. Mother-child links were identified by the WADLB, using the MNS  
40 and Birth Register and enabling linkage between maternal mental health records and our study  
41 cohort.  
42  
43

### 44 *Primary outcome*

45 Maternal mental health problems were measured using administrative data on service contacts,  
46 including mental health-related inpatient hospitalisations (from HMDC) and mental health related  
47 outpatient contacts (from MHIS). Mental health diagnoses were classified using ICD-10-AM codes  
48 (International Statistical Classification of Diseases and Related Health Problems-Tenth edition-  
49 Australian Modification) and mapping tables were used to recode different editions of ICD codes.  
50 Mothers were classified as having a mental health-related hospitalisations or contact if they had a  
51 mental health-related ICD diagnosis (primary and/or secondary).  
52  
53

54 Mental health diagnoses were classified into one of eleven groups using ICD codes: organic  
55 disorders, substance-related disorders, schizophrenia, mood disorders, anxiety, personality  
56 disorders, intellectual disabilities, disorders of psychological development, intentional self-harm,  
57 Other mental health related contacts and Broader mental health related contacts (Appendix A, Table  
58 A). The 'Broader' group included contacts that do not meet the specific criteria for a mental health  
59 diagnosis, but the principal or secondary diagnosis is related to mental health issues. These contacts  
60

1  
2  
3 are considered less severe mental health issues than the diagnoses-specific groups. The most  
4 prevalent ICD-10 code found in the 'Broader' group were related to: 'Other problems with housing  
5 and economic circumstances' (Z59.8) and 'Personal history of psychoactive substance abuse' (Z86.4).  
6

7 A broad approach was taken to examine the timing or onset of maternal mental health problems,  
8 given that child development is influenced by events after birth and those that take place in-utero  
9 and prior to conception (Zubrick et al., 2014). For all in-scope mothers, we coded whether a mental  
10 health contact had ever occurred, as well as contacts that were proximal to the birth (1 year prior  
11 and 1 year post) and more distal events (up to 5 years prior). It should be noted that the term  
12 'mental health' is used here to describe the diagnoses of mental health problems in service settings,  
13 and is used here in preference to 'social and emotional wellbeing' (SEWB). Mental health is one  
14 aspect of the broader concept of SEWB and its scope does not include the aspects of SEWB that  
15 pertain to spiritual wellbeing, culture, connection to land and the broader issues that impact on the  
16 wellbeing of Aboriginal communities.  
17  
18

### 19 *Covariates*

20  
21 Area-level socio-economic status (SES) was measured using the Index of Relative  
22 Advantage/Disadvantage 2011 developed by the Australian Bureau of Statistics (ABS). The index  
23 ranks the relative level of disadvantage of areas using the attributes of all persons (Aboriginal and  
24 non-Aboriginal) in each Statistical Area level 1 (SA1; the smallest area of output for the Australian  
25 Census of Population and Housing), and includes measures of income, educational attainment,  
26 employment status and occupational skill. Quintiles were determined based on the distribution of  
27 values for the total Australian population (for Aboriginal and non-Aboriginal children) (ABS, 2013a).  
28

29 The 2011 Remoteness Areas (RAs) classification developed by the ABS was used to determine  
30 geographical remoteness. The classification divides Australia into broad regions that share common  
31 characteristics of remoteness for statistical use. The RAs are based on the Accessibility/Remoteness  
32 Index of Australia (ARIA+), and include five categories—ranging from Major cities (Perth  
33 metropolitan area), to inner regional, outer regional, remote and very remote areas (ABS, 2013b).  
34

### 35 *Statistical analysis*

36  
37 The study utilises descriptive and inferential statistical methods to ascertain the scale and change  
38 over time of Aboriginal children whose mother suffered from a mental illness. Simple univariate and  
39 multivariate analyses were used to investigate the trajectory and change over time. To analyse  
40 change over time, a trend analysis was undertaken using a univariate Generalised Linear Model  
41 (GLM) with Poisson distribution, log link function and adjusting for the population (births) in each  
42 year. Trends are presented as the percentage change in the incidence rate ratios (IRR) for each  
43 increase in birth year and their 95% confidence interval (CI).  
44  
45

46 Univariate and multiple logistic regression modelling were used to analyse factors associated with  
47 the odds of Aboriginal children being born to a mother who had a mental health problem (contact),  
48 clustering children by mothers, and adjusting by maternal age at birth, remoteness, and SES.  
49 Maternal age and SES are typically associated with mental health outcomes in mothers (O'Donnell et  
50 al, 2013), while service access is likely to differ by geographical remoteness (Highet & Goddard,  
51 2014).  
52

### 53 *Ethical approvals*

54  
55 The study was approved by the Western Australian Aboriginal Health Ethics Committee (reference  
56 416), Murdoch University Human Research Ethics Committee (reference 2014/025) and Western  
57 Australian Department of Health WA Human Research Ethics Committee (reference 2014/21).  
58  
59  
60

## 2. Analysis

Of the 43,383 Aboriginal children born in Western Australia between 1990 and 2013, 61.3% (26,595) were born to a mother who had ever had a mental health contact. In the cohort overall, 49% were female, the majority (57%) were born to a mother aged 20-29 years, 60% were living in an area within the highest quintile of socio-economic disadvantage, 34% were from a major city and another 40% from a remote/very remote area (Table 1), with similar proportions among Aboriginal children born to a mother with a mental health contact.

**Table 1.** Descriptive statistics of Aboriginal children born between 1990 and 2013. Prevalence of maternal mental health.

	Cohort		Aboriginal children born to a mother who had MH contact					
			5 years pre birth		1 year pre birth		1 year post birth	
	N	%	N	%	N	%	N	%
N Aboriginal children	43,383	-	12,043	27.8	6,723	15.5	6,479	14.9
<i>Gender</i>								
Female	21,162	48.8	5,909	49.1	3,291	49.0	3,208	49.5
Male	22,210	51.2	6,130	50.9	3,429	51.0	3,268	50.4
<i>Maternal age at birth</i>								
<20 years	10,385	23.9	2,354	19.5	1,446	21.5	1,403	21.7
20-29 years	24,899	57.4	7,036	58.4	3,775	56.2	3,641	56.2
30-39 years	7,700	17.7	2,529	21.0	1,429	21.3	1,360	21.0
>39 years	396	0.9	124	1.0	73	1.1	75	1.2
<i>Socio-economic status*</i>								
1 (high disadvantage)	25,831	59.5	7,281	60.5	4,090	60.8	3,915	60.4
2	8,295	19.1	2,180	18.1	1,168	17.4	1,149	17.7
3	4,189	9.7	1,116	9.3	631	9.4	623	9.6
4	2,137	4.9	626	5.2	371	5.5	349	5.4
5 (low disadvantage)	1,165	2.7	290	2.4	155	2.3	139	2.1
<i>Remoteness*</i>								
Major Cities	14,607	33.7	4,424	36.7	2,650	39.4	2,563	39.6
Inner Regional	2,254	5.2	526	4.4	288	4.3	260	4.0
Outer Regional	6,512	15.0	1,604	13.3	797	11.9	777	12.0
Remote	7,894	18.2	1,841	15.3	880	13.1	841	13.0
Very Remote	9,690	22.3	2,930	24.3	1,722	25.6	1,653	25.5

\*Note Maternal age, SES and Remoteness sub-totals do not sum 100% due to missing records.

Almost 30% of cohort children were born to a mother with at least one mental health contact in the 5 years prior to birth, with 15% reported in both the year prior and year post birth. The prevalence trajectories were similar for each of these three indicators, amounting to an average increase of 4-5% per year over the whole 1990-2013 study period (95% CI). The pattern was characterised by relatively large year-on-year increases—of 7-10% per year, on average—that peaked in 2007 (to 410 per 1,000 births for the 5 years prior to birth indicator, and 268 and 247 per 1,000 births for 1 year prior and 1 year post birth, respectively) with subsequent moderate decreases to 2013 (5-6% per year)(Figure 1).



Substance-related disorders, Mood disorders, Anxiety and 'Broader' mental disorders were the most prevalent disorder types in the 5 years prior to birth (Figure 2; see Appendix A Table A for diagnoses within the 'Broader' mental health contacts category, and Figure A and Figure B for trends by diagnosis type for 1 year prior and 1 year post birth, respectively). The largest change over time was exhibited in the 'Broader' mental disorders category (11% per year over the study period; 95% CI: 1.08-1.15), with small or negligible changes in the other ten groups—for example, an average increase of 1% per year (95% CI: 0.99-1.02) for Substance-related disorders, 3% per year (95% CI: 1.02-1.04) for Anxiety, and 4% per year (95% CI: 1.02-1.06) for Mood disorders.

Broadly speaking, the results consistently highlight small to moderate effects sizes for the associations between SES, remoteness and maternal age on maternal mental health contacts (Table 2). This includes contacts recorded within 5 years, 1 year prior to birth and 1 year post-birth. As a general rule, the pattern and scale of effects for each covariate were similar regardless of when the mental health event was recorded. The pattern of effects for SES was akin to a small threshold effect, with Aboriginal children in all other quintiles at elevated odds of having a maternal mental health contact 5 years prior to birth compared with those in the lowest quintile of disadvantage—although the results only reached statistical significance for the highest quintile of disadvantage (OR=1.21; CI: 1.03–1.43) and second lowest quintile (OR=1.27; CI: 1.04–4.53).

There was a no statistically significant difference in the odds of a maternal mental health contact between children from Major Cities (reference group) and those from Very remote areas, irrespective of the follow up period. Living in Inner Regional areas (OR=0.69 for 5 years prior to birth; 95% CI: 0.60-0.78), Outer Regional areas (OR=0.74; 95% CI: 0.68-0.81) and Remote areas (OR=0.70; 95% CI: 0.64-0.76) was associated with a lower likelihood of maternal mental health contact relative to those born in Major Cities.

Finally, Aboriginal children born to a mother aged over 20 years were at increased odds of having a maternal mental health contact, both prior and post birth. While the highest odds prior to birth were for the 30-39 years age group (5 years prior to birth: OR=1.71, CI: 1.57-1.85; 1 year prior to birth: OR=1.44, CI: 1.31-1.58), after birth the greatest odds were for those born in the over 39 maternal age group (OR=1.45, CI: 1.09-1.92).

**Table 2.** Multiple logistic regression: Odds of having a mother who had a mental health contact 5 years prior birth, 1 year prior birth and 1 year post birth.

	Odds ratio (95% CI)		
	5 Years prior birth	1 Year prior birth	1 Year post birth
<i>Socio-economic status (quintiles)</i>			
1 (high disadvantage)	1.21 (1.03-1.43)*	1.14 (0.94-1.39)	1.31 (1.06-1.62)*
2	1.10 (0.93-2.30)	1.01 (0.82-1.23)	1.20 (0.96-1.49)
3	1.12 (0.94-3.34)	1.08 (0.88-1.34)	1.29 (1.03-1.62)*
4	1.27 (1.04-4.53)*	1.27 (1.01-1.59)*	1.45 (1.14-1.84)*
5 (low disadvantage)	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
<i>Remoteness</i>			
Major Cities	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Inner Regional	0.69 (0.60-0.78)*	0.65 (0.56-0.75)*	0.61 (0.52-0.71)*
Outer Regional	0.74 (0.68-0.81)*	0.63 (0.57-0.69)*	0.64 (0.58-0.70)*
Remote	0.70 (0.64-0.76)*	0.57 (0.52-0.62)*	0.56 (0.51-0.62)*
Very Remote	0.98 (0.91-1.06)	0.96 (0.89-1.04)	0.96 (0.88-1.04)

*Maternal age at birth*

	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
<20 years			
20-29 years	1.37 (1.29-1.46)*	1.13 (1.05-1.22)*	1.12 (1.04-1.21)*
30-39 years	1.71 (1.57-1.85)*	1.44 (1.31-1.58)*	1.40 (1.28-1.54)*
>39 years	1.51 (1.18-1.93)*	1.37 (1.03-1.81)*	1.45 (1.09-1.92)*

\*p&lt;0.05

**3. Discussion**

There was a distinct increase in the prevalence of Aboriginal children born to a mother with a mental health problem between 1990 and 2013 (4-5% per year), regardless of whether mental health was measured at 5 years prior to birth, 1 year prior to birth or 1 year post-birth. The overall increasing trend in mental health contacts can potentially be explained by an increase in mental health service provision, in addition to a possible increase in mental health disorders among mothers (Colvin et al., 2013). Australian Government spending on mental health per capita more than doubled between 1992 and 2011, outstripping spending at the national level, and providing a substantial boost to the mental health workforce (DoHA, 2013) and the funding support for General Hospitals, Residential and Ambulatory services, and the non-government sector to deal with mental health issues (DoHA, 2013).

We observed large increases in mental health contacts from 1990, to a peak in 2007 and a subsequent moderate drop in the years to 2013. The change after 2007 could be attributed to the introduction of the Australian Government's *Better Access to Mental Health* initiative in November 2006 (APS, 2007). This initiative included additional Medicare items for psychological services for people with mental health disorders, and enabled affordable access to mental health care, including private clinics and practitioners. This may have diverted patients from public hospitals and mental health services to the private sector or Aboriginal Medical Services, which would not have been captured in our data.

The overall contact rates affirm that mental health problems place a considerable burden on Aboriginal Australia, and are of a higher magnitude than that experienced in non-Aboriginal populations (AHMAC, 2017). A recent study by O'Donnell et al. (2013) highlighted that 1.7% of mothers had a mental health contact in the year before birth in 2005; this compares with 26.7% of Aboriginal mothers in this study (O'Donnell et al., 2013). The deleterious effects of the unique post-colonial history of Aboriginal Australia is now well understood, and include issues of dispossession, exclusion, discrimination and marginalisation that have had a profoundly negative impact on the social and emotional wellbeing of Aboriginal people (Shepherd et al., 2012). The stress associated with racial discrimination has, increasingly, been shown to affect the mental wellbeing of a substantial proportion of Aboriginal people in various, often complex ways (Paradies et al., 2008; Shepherd et al., 2017). In addition to the direct effects of interpersonal racism on wellbeing, they include the indirect effects that stem from reduced and unequal access to the range of medical, health promotion and other resources that are required for good family planning and pregnancy health, and the downstream consequences of withdrawing from health care (Paradies, 2007; Brondolo et al, 2008).

There was a consistent 2-fold difference between the prevalence of mental health contacts in the period 5 years prior to birth and 1 year prior. This suggests that many of the mental health problems that women develop earlier in life are chronic and complex at the time of conception, during pregnancy and at birth and speaks to the complexities of accumulated and transgenerational trauma

1  
2  
3 that can manifest with a significant life event such as pregnancy and childbirth (Atkinson, Nelson and  
4 Atkinson, 2010). Concomitantly, given the large proportion of mothers with a contact in the year  
5 pre- and post-birth, the results reinforce that the period of pregnancy and early motherhood, crucial  
6 for children's early development, are also critical periods for the mental health care of mothers.  
7 Early intervention and support for women with a trauma informed lens in the earliest stages of  
8 family planning are required to alleviate the burden of mental health problems at and after birth.  
9 Previous research has highlighted the need for policies directed to the development of a holistic  
10 health care model, with a multisector approach, offering culturally appropriate services for  
11 Aboriginal people, capable of identifying and addressing the complex set of risk factors these  
12 mothers, children and families are facing (Huntsman, 2008; Twizeyemariya et al., 2017; Marriott &  
13 Ferguson-Hill, 2014; Coates, 2017; Hancock, 2006).

17 As mentioned earlier, the child can be affected directly by their mother's mental illness by  
18 intrauterine exposure to depression or anxiety, and after birth through direct exposure to parental  
19 mental illness, as postnatal depression. Previous research has found that 10-13% of pregnant  
20 woman experienced antenatal depression and anxiety (Evans et al., 2001), and over 14% may  
21 experience postnatal depression (Milgrom et al., 2005). If these mental health issues are also  
22 associated with drug and alcohol use during pregnancy, domestic violence, and pre-existing mental  
23 health problems, the mental health of the mother, child and family may also be affected (Ferguson-  
24 Hill, 2010). For many Aboriginal mothers, especially for those living in remote/very remote areas,  
25 giving birth away from country, family members and traditional ways of birthing may also cause  
26 additional stress on them and their child which could affect the child's future development  
27 (Hancock, 2006). Parental mental illness can affect the cognitive, emotional, social and behavioural  
28 development of the child, and therefore the literature highlights the importance of early  
29 intervention (Manning & Gregoire, 2009).

33 We observed little change in the prevalence of diagnosis-specific contacts—including the more  
34 prevalent categories of Substance-related disorders, Anxiety and Mood disorders—despite the  
35 introduction of policies to provide better support for highly vulnerable Aboriginal populations.  
36 However, reductions were found for 'Broader' mental health diagnoses after 2007, which may  
37 reflect an actual reduction in less severe mental health related problems among mothers and/or  
38 that the *Better Access to Mental Health* initiative has been effective in providing the opportunity for  
39 broader access to private clinics and practitioners for treatment of these problems.

42 Older maternal age was associated with a higher likelihood of maternal mental health problems  
43 among Aboriginal children. This finding is in contrast to a recent study of all Western Australian  
44 mothers, which showed an increased burden among teenagers (O'Donnell et al., 2013). Pregnant  
45 Aboriginal women over 30 years of age may have greater caring responsibilities, on average, given  
46 the distinctly higher fertility rates at younger ages among Aboriginal women (ABS, 2017). This may  
47 create extra stress during pregnancy and potentially exacerbate existing social and emotional  
48 difficulties. The finding, however, is also distinct from the typical age profile of mental health  
49 problems among Aboriginal women more broadly (ABS, 2013c), which may reflect a different  
50 pattern of socioeconomic and living circumstances among Aboriginal women giving birth in their 30s  
51 and 40s.

### 55 3.1. Limitations

57 Mental health disorders captured in this study are those related to hospitalisations (HMDC) and  
58 contacts with mental health services (MHIS), with diagnoses classified using ICD-10-AM codes.  
59 However, it is important to mention that not all people with mental health issues have been  
60

1  
2  
3 diagnosed or are receiving assistance for their condition—accordingly, our results under-estimate  
4 the scale of mental health problems in mothers of Aboriginal children. This is particularly pertinent  
5 to those living in rural and remote areas, where there may be limited or no access to mental health  
6 services.  
7

8 As mentioned in Section 2, the spatial or geographical distribution of the population was measured  
9 using the variable Remoteness Areas (RAs) developed by ABS, based on information from the 2011  
10 Australian Census of Population and Housing. First, it should be noted that the prevalence estimates  
11 by geographical area are not reflective of the distribution of health or mental health services but the  
12 actual area of residence of each individual. Second, the 2011 RAs may not have always accurately  
13 reflected the individual geographical location at birth, due to changes in classification over time or  
14 individuals moving from one area to another.  
15  
16

17 This study does not intend to evaluate the “Better Access” initiative. The datasets used did not allow  
18 us to differentiate between consumers of the “Better Access” program from those who didn’t.  
19 Information on private consults for mental health issues with GP or private clinics such as Aboriginal  
20 Medical Services was not available. This study only considers the potential effect of this policy  
21 among the cohort under analysis. A full evaluation of the program was developed by the University  
22 of Melbourne in 2011 (Pirkis et al., 2011).  
23  
24

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31 supported by a National Health and Medical Research Council (Early Career Fellowship 1012439).  
32 RM was supported by an Australian Research Council (Discovery Indigenous Grant IN120100026).  
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34  
35

#### 36 **5. Authors contributions**

37 All authors made a substantial contribution to the study concept and design, and interpretation of  
38 the data. FL and JW executed the statistical analyses. FL and CCJS drafted the manuscript. All authors  
39 revised the draft critically for important intellectual content, and have approved the final version of  
40 the manuscript.  
41  
42

#### 43 **6. Data shearing statement**

44 The authors do not have permission to share the data used in this project, which were provided by  
45 the Data Linkage Branch of the Western Australian Government Department of Health under strict  
46 conditions.  
47  
48

#### 49 **7. Competing interest statement**

50 All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf)  
51 and declare: no support from any organisation for the submitted work; no financial relationships  
52 with any organisations that might have an interest in the submitted work in the previous three  
53 years; no other relationships or activities that could appear to have influenced the submitted work.  
54  
55

#### 56 **8. Patient and Public Involvement statement**

57 Direct PPI was not applicable to this study given that it utilised de-identified linked administrative  
58 data. This research has approval from the Western Australian Aboriginal Health Ethics Committee  
59 (reference 416), Murdoch University Human Research Ethics Committee (reference 2014/025) and  
60

Western Australian Department of Health WA Human Research Ethics Committee (reference 2014/21). The study was also overseen by Prof. Rhonda Marriott, who has strong matrilineal connections to Nyikina people of the Kimberley. This ensured that the design, development and analysis of the research incorporated Indigenous views and advice.

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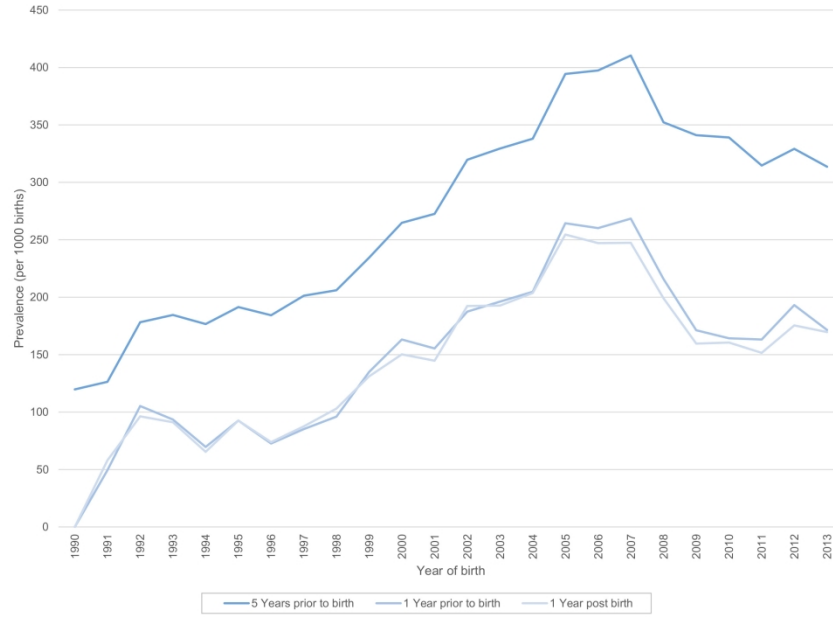


Figure 1. Prevalence of Aboriginal children born to a mother who had a mental health related contact 5 years prior to birth, 1 years prior to birth and 1 year post birth, by year of birth 1990-2013.

279x215mm (300 x 300 DPI)

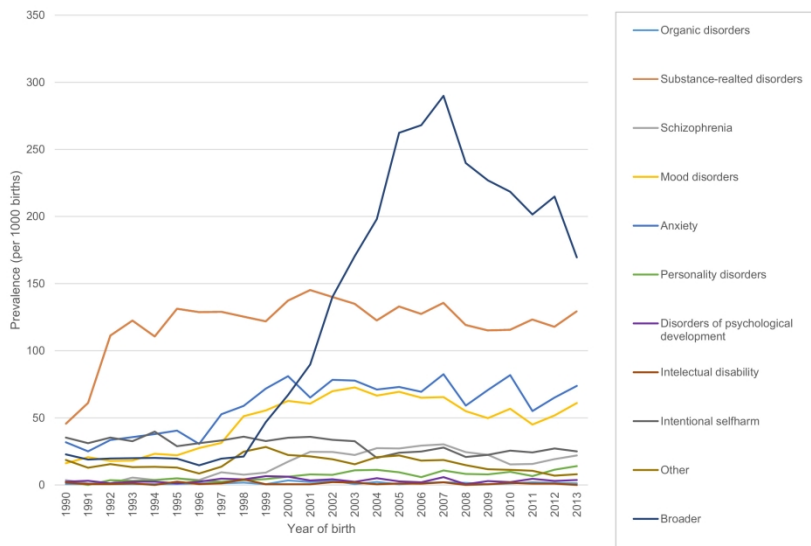


Figure 2. Prevalence of children whose mother had a mental health related contact within 5 years prior to birth, by year of birth and diagnosis type.

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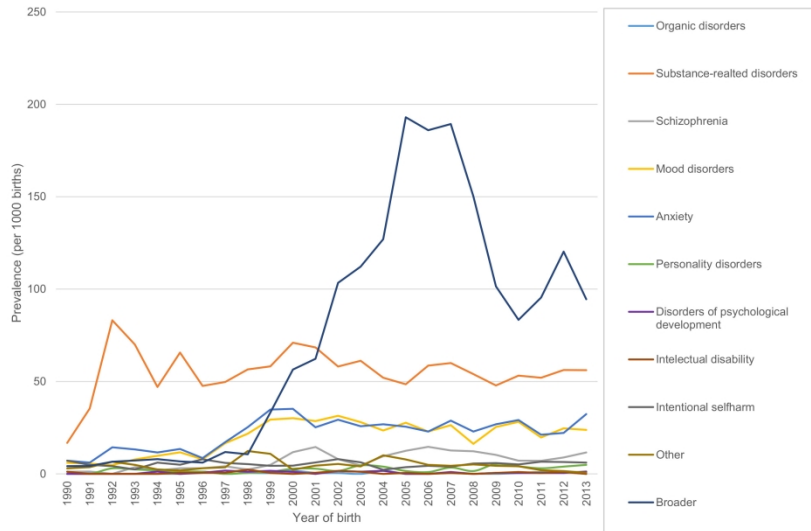


Figure A. Prevalence of children whose mother had a mental health related contact within 1 year prior to birth, by year of birth and diagnosis type.

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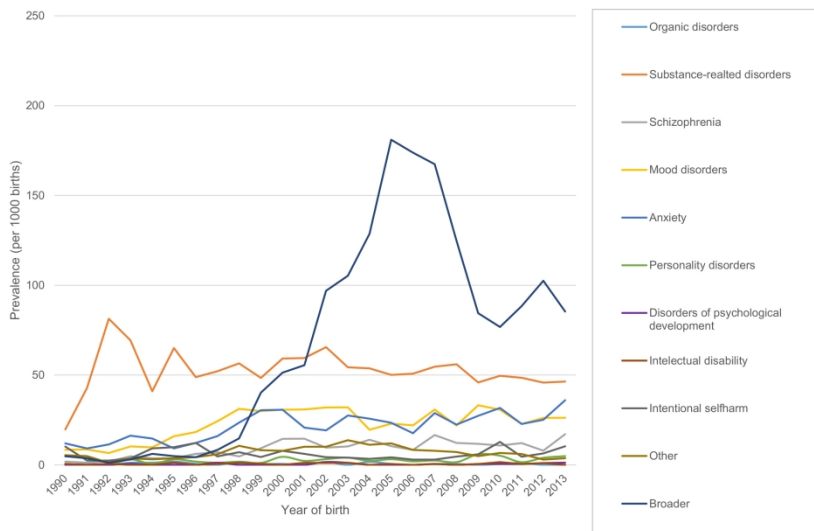


Figure B. Prevalence of children whose mother had a mental health related contact within 1 year post birth, by year of birth and diagnosis type.

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- **Appendix A**

**Table A.** Mental health related diagnoses groups.

Mental Health disorders	ICD-9-CM	ICD-10-AM
Organic disorder	290, 293, 294, 310	F00-F09, G30
Substance-related disorder	291, 292, 303, 304, 305	F10-F19, F55
Schizophrenia	295, 296, 297, 298	F20-F29, F33.3, F30, F31, F32.1-F32.8, F33.1-F33.9, F34.8, F34.9, F38, F39
Mood disorder	296, 300.4, 311,	F32.0, F32.9, F33.0, F34.1
Anxiety	300.0, 300.2, 300.3, 300.8, 308, 309	F40-F43, F45, F48, F63.3, F68
Personality disorder	301	F60, F61, F62, F68.1, F68.8, F69
Intellectual disability (IQ)	317, 318, 319	F70-F79
Disorders of psychological development	299, 307.2, 307.3, 307.6, 307.7, 312, 313, 314, 315	F80-F89, F90-F98
Intentional self-harm	E950-E959	X6, X7, X80-X84
Other mental health related contacts	300.5, 300.6, 300.7, 300.9, 302, 306, 307.0, 307.1, 307.4, 307.5, 307.8, 307.9, 310, 316	F44, F48, F50, F51, F52, F53, F54, F59, F63, F64, F65, F66, F95, F98, F99
Broader mental health related contacts	368.1, 799.2, V11, V15.4, V40, V66.3, V67.3, V70.1, V70.2, V71.0, V79	G30, R44, R45, R46, R47, R48, Y10-Y34, Z00.4, Z03.2, Z04.6, Z09.3, Z13.3, Z50.2, Z50.3, Z50.4, Z54.3, Z56, Z59-Z65, Z70, Z71.4, Z71.5, Z71.6, Z71.9, Z86.4, Z86.5, Z91.4, Z91.5

**Figure A.** Prevalence of children whose mother had a mental health related contact within 1 year prior to birth, by year of birth and diagnosis type.

**Figure B.** Prevalence of children whose mother had a mental health related contact within 1 year post birth, by year of birth and diagnosis type.

# Reporting checklist for cohort study.

Based on the STROBE cohort guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cohort reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title	<a href="#">#1a</a>	Indicate the study's design with a commonly used term in the title or the abstract	0
Abstract	<a href="#">#1b</a>	Provide in the abstract an informative and balanced summary of what was done and what was found	1

1	Background / rationale	<a href="#">#2</a>	Explain the scientific background and rationale for the investigation being reported	2-3
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5	Objectives	<a href="#">#3</a>	State specific objectives, including any prespecified hypotheses	2-3
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9	Study design	<a href="#">#4</a>	Present key elements of study design early in the paper	3
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13	Setting	<a href="#">#5</a>	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
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17	Eligibility criteria	<a href="#">#6a</a>	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up.	2-3
18				
19		<a href="#">#6b</a>	For matched studies, give matching criteria and number of exposed and unexposed	n/a
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21	Variables	<a href="#">#7</a>	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2-3
22				
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25	Data sources / measurement	<a href="#">#8</a>	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	2-3
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29	Bias	<a href="#">#9</a>	Describe any efforts to address potential sources of bias	9
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33	Study size	<a href="#">#10</a>	Explain how the study size was arrived at	
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1	Quantitative variables	<a href="#">#11</a>	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	2-3	
2		Statistical methods	<a href="#">#12a</a>	Describe all statistical methods, including those used to control for confounding	2-3
3			<a href="#">#12b</a>	Describe any methods used to examine subgroups and interactions	2-3
4			<a href="#">#12c</a>	Explain how missing data were addressed	n/a
5			<a href="#">#12d</a>	If applicable, explain how loss to follow-up was addressed	n/a
6			<a href="#">#12e</a>	Describe any sensitivity analyses	n/a
7		Participants	<a href="#">#13a</a>	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	2-3
8	<a href="#">#13b</a>		Give reasons for non-participation at each stage	n/a	
9	<a href="#">#13c</a>		Consider use of a flow diagram	n/a	
10	Descriptive data	<a href="#">#14a</a>	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5-7	
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1		<a href="#">#14b</a>	Indicate number of participants with missing data for each	n/a
2			variable of interest	
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6		<a href="#">#14c</a>	Summarise follow-up time (eg, average and total amount)	n/a
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10	Outcome data	<a href="#">#15</a>	Report numbers of outcome events or summary measures	5-7
11			over time. Give information separately for exposed and	
12			unexposed groups if applicable.	
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17		<a href="#">#16a</a>	Give unadjusted estimates and, if applicable, confounder-	5-7
18			adjusted estimates and their precision (eg, 95% confidence	
19			interval). Make clear which confounders were adjusted for	
20			and why they were included	
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27		<a href="#">#16b</a>	Report category boundaries when continuous variables were	5-7
28			categorized	
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33		<a href="#">#16c</a>	If relevant, consider translating estimates of relative risk into	n/a
34			absolute risk for a meaningful time period	
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38	Other analyses	<a href="#">#17</a>	Report other analyses done—e.g., analyses of subgroups	13-14
39			and interactions, and sensitivity analyses	
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43	Key results	<a href="#">#18</a>	Summarise key results with reference to study objectives	5-7
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46	Limitations	<a href="#">#19</a>	Discuss limitations of the study, taking into account sources	9-10
47			of potential bias or imprecision. Discuss both direction and	
48			magnitude of any potential bias.	
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1	Interpretation	<a href="#">#20</a>	Give a cautious overall interpretation considering objectives,	5-7
2			limitations, multiplicity of analyses, results from similar	
3			studies, and other relevant evidence.	
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8	Generalisability	<a href="#">#21</a>	Discuss the generalisability (external validity) of the study	n/a
9			results	
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14	Funding	<a href="#">#22</a>	Give the source of funding and the role of the funders for the	10
15			present study and, if applicable, for the original study on	
16			which the present article is based	
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24 the [EQUATOR Network](#) in collaboration with [Penelope.ai](#)  
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# BMJ Open

## Trends in mental health-related contacts among mothers of Aboriginal children in Western Australia (1990-2013): A linked data population-based cohort study of over 40,000 children.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-027733.R1
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Date Submitted by the Author:	01-Mar-2019
Complete List of Authors:	Lima, Fernando; Telethon Kids Institute Shepherd, Carrington; Telethon Kids Institute; University of Western Australia Wong, Janice; Telethon Kids Institute; University of Western Australia, Centre & Discipline of Child and Adolescent Psychiatry, Psychosomatics & Psychotherapy O'Donnell, Melissa; University of Western Australia; Telethon Kids Institute Marriott, Rhonda; Murdoch University, Ngangk Yira Research Centre for Aboriginal Health & Social Equity; Telethon Kids Institute
<b>Primary Subject Heading</b>:	Mental health
Secondary Subject Heading:	Mental health, Health policy, Health services research, Paediatrics, Public health
Keywords:	Maternal health, Aboriginal, Indigenous, MENTAL HEALTH, Linked administrative data, Hospitalisations

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Manuscripts

# Trends in mental health-related contacts among mothers of Aboriginal children in Western Australia (1990–2013):

A linked data population-based cohort study of over 40 000 children.

Fernando Lima<sup>1</sup>, Carrington CJ Shepherd<sup>2</sup>, Janice Wong<sup>3</sup>, Melissa O'Donnell<sup>2</sup>, Rhonda Marriott<sup>4</sup>.

For peer review only

## Affiliations:

<sup>1</sup>Telethon Kids Institute, Perth, WA, Australia.

<sup>2</sup>Telethon Kids Institute. The University of Western Australia, Perth, Australia.

<sup>3</sup>Telethon Kids Institute. The University of Western Australia. Department of Health Western Australia, Perth, Australia.

<sup>4</sup> Telethon Kids Institute. The University of Western Australia, Perth, Australia. Ngangk Yira Research Centre for Aboriginal Health & Social Equity, Murdoch University, Perth, WA, Australia.

**Address correspondence to:** Fernando Lima, Telethon Kids Institute, Linked Analytics and Social Policy. Northern Entrance, Perth Children's Hospital, 15 Hospital Avenue, Nedlands, WA, AUS 6009. Email: fernando.lima@telethonkids.org.au

## Abstract

**Objective** This study examines the scale of maternal mental health-related contacts among Australian Aboriginal children over time, and associations with geographical remoteness and maternal age.

**Design** A retrospective cohort study of the prevalence of maternal mental health-related contacts among Aboriginal children born in Western Australia between 1990 and 2013.

**Setting** Population of Western Australia. Used de-identified linked administrative data from the Western Australian Department of Health.

**Participants** All Aboriginal children born in Western Australia between 1990 and 2013 and their mothers.

**Primary outcome measure** Prevalence of maternal mental health-related contacts among Aboriginal children born between 1990 and 2013. Mental health-related contacts were identified using mental health-related inpatient hospitalisations and outpatient contacts.

**Results** Almost 30% of cohort children were born to a mother with at least one mental health contact in the 5 years prior to birth, with 15% reported in both the year prior and year post birth. There was a distinct increase in the prevalence of maternal mental health contacts between 1990 and 2013 (4-5% per year, with a peak in 2007). Maternal mental health contacts were associated with living in more disadvantaged areas and Major Cities, and having a mother aged over 20 years at birth.

**Conclusions** The study affirms that mental health issues place a considerable burden on Aboriginal Australia, and suggests that many of the mental health issues that women develop earlier in life are chronic at the time of conception, during pregnancy and at birth. Early intervention and support for women in the earliest stages of family planning are required to alleviate the burden of mental health problems at and after birth. There is a clear need for policies directed to the development of an holistic health care model, with a multisector approach, offering culturally appropriate services for Aboriginal people.

**Keywords:** Maternal health; Aboriginal; Indigenous; mental health; linked administrative data; hospitalisations.

## Strength and limitations of the study

- This study used de-identified administrative linked data from the Western Australian Department of Health. This powerful resource gives researchers access to population data, both large in scale and time period covered, not previously feasible through survey methods.
- By analysing data on the prevalence of mental health contacts in Aboriginal parents, the study filled a gap in the existing literature.
- Three different follow-up periods were examined which provides a perspective on maternal mental health prevalence in the sensitive periods of child development spanning pre-conception to infancy.
- This study was unable to capture people with mental health issues that have not been diagnosed or are not receiving assistance for their condition. For example, those living in rural and remote areas, where there may be limited or no access to mental health services.
- Information on mental health consultations with GPs, private practitioners (psychiatry, psychology) and Aboriginal Medical Services was not available.

## Background

Mental health issues affect almost half of the Australian population at some point during their lifetime<sup>1</sup>. The impact of mental health issues not only affects the person experiencing it but also those around them, with an extensive literature showing that parental mental illness can impact upon children and their outcomes<sup>2,3</sup>. It is estimated that between 21% and 23% of children living in an Australian household have at least one parent with a mental illness<sup>4</sup>. Recent research has also highlighted a steady increase in children born to a mother with a mental health issues in the year before birth—at 27 per 1000 births<sup>5</sup>.

Mental health issues are a considerable burden for the Aboriginal population, with rates of suicide deaths, hospitalisation for intentional self-harm and high psychological distress reported at 2-3 times higher than for other Australians<sup>6,7</sup>. These inequalities have, at least in part, been attributed to the unique post-colonisation history of Aboriginal Australia and the associated trauma of persistent discrimination, marginalisation, exclusion and dispossession<sup>8,9</sup>. Past policies and practices of forced removal of Aboriginal children from family and kinship networks has had a significant impact and resulted in adverse consequences on mental health and social and emotional wellbeing<sup>2</sup>.

The mechanisms by which parental mental health impacts on children are complex and multifaceted. They include direct mechanisms, such as genetic inheritance, intrauterine and antenatal exposure to stress, anxiety and depression, and disrupted attachment formation between the parent and infant which can affect emotional, social, and cognitive development<sup>3</sup>. In addition, socioeconomic disadvantage, marital discord and substance use have all been described as posing a risk to child mental health, via indirect mechanisms<sup>3,10</sup>. Previous research has identified the main mental health problems affecting parenting are depression, bipolar disorder, schizophrenia, borderline personality disorder, post-traumatic stress disorder, and antisocial personality disorder<sup>11</sup>.

During adolescence, children of parents with mental illness may become carers of their own parents, which can influence their emotional and social growth<sup>2</sup> and potentially lead to the development of mental health issues later in their life. This negative outcome can impact children's own educational and employment outcomes leading to intergenerational disadvantage. Given the disproportionate

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3 burden of disadvantage among Aboriginal Australians, improving social and psychological conditions  
4 has the potential to reduce inequalities within Aboriginal populations that stretch across  
5 generations<sup>8</sup>.  
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7 There is a lack of data on the prevalence of mental health contacts in Aboriginal parents in Australia,  
8 reflecting, in part, the limitations of available population data. This study makes use of  
9 administrative data from hospitals and mental health clinics in Western Australia to address this  
10 information gap, with a primary focus on mothers of Aboriginal children and mental health contacts  
11 in the perinatal period. Specifically, we aim to: (1) quantify the prevalence of mental health contacts  
12 among Aboriginal mothers; (2) examine how prevalence rates have changed from 1990-2013; (3)  
13 examine the timing of maternal mental health-related contacts, including events proximal to the  
14 birth (1 year prior and 1 year post) and more distal events (up to 5 years prior); and (4) test the  
15 association between maternal mental health-related contacts and key sociodemographic indicators.  
16  
17

## 18 **1. Methods**

### 19 1.1. Data source

20  
21 The mental health system in Western Australia includes a mix of public and private services provided  
22 in a range of settings—hospitals, community mental health units or centres, and private  
23 practitioners (GPs) or other mental health specialists. In general, patients are referred from a GP or  
24 other health providers when mental health services are required. Patients can receive mental health  
25 care as an inpatient, admitted to hospital, clinic or other mental health service, or as an outpatient,  
26 when they receive treatment without being admitted to hospital. Aboriginal Australians can access  
27 mainstream or Aboriginal-specific services, with the latter generally available through community  
28 clinics, services provided by Aboriginal Community Controlled Health Organisations (ACCHOs) and  
29 other health care facilities, and some public hospitals. Mental health-related administrative data are  
30 available to third party researchers (with appropriate permissions) from the Western Australian  
31 Department of Health. Data for this study were de-identified and included mental health-related  
32 hospitalisations in private and public hospitals as well as public mental health service contacts.  
33  
34

35 Data are sourced from the Hospital Morbidity Data Collection (HMDC) (1970-current), Mental Health  
36 Information System (MHIS) (1966-current), Midwives Notification System (MNS) (1980-current) and  
37 Birth Register (BR) (1974-current). The datasets were linked by the Western Australian Data Linkage  
38 Branch (WADLB) using probabilistic matching and a robust and internationally accepted privacy  
39 preserving protocol<sup>12</sup>. Only a unique identifier on the individual's clinical information was provided  
40 to the researchers, and any identifying information was removed.  
41  
42

### 43 1.2. Study design and statistical analysis

44 This is a retrospective cohort study of the prevalence of maternal mental health contacts among  
45 Aboriginal children born in Western Australia between 1990 and 2013, inclusive. STROBE cohort  
46 reporting guidelines were utilised<sup>13</sup>.  
47

48 Births were identified from the MNS and Birth Registrations. Indigenous status was identified using  
49 WADLB's Derived Indigenous Status Flag, developed in conjunction with the "Getting Our Story  
50 Right" indigenous identification project by Christensen et al.<sup>14</sup>. This indicator uses a multi-stage  
51 median approach across a wide range of datasets to produce a single indicator of Indigenous status  
52 for each individual and is considered an optimal approach to identifying Aboriginal persons in  
53 administrative datasets. Mother-child links were identified by the WADLB, using the MNS and Birth  
54 Register enabling linkage between maternal mental health records and our study cohort.  
55  
56

### 57 *Primary outcome*

58 Maternal mental health contacts were measured using administrative data on service contacts,  
59 including mental health-related inpatient hospitalisations from all public and private hospitals in WA  
60

(the HMDC includes information on public and private acute hospitals, public and private psychiatric hospitals and private day surgeries ) and mental health related contacts from the WA mental health services, including all psychiatric episodes of inpatient (public and private) and outpatients (public only)(the MHIS collects data from community residential facilities, acute general hospitals, psychiatric inpatient units and clinics and psychiatric day centres).

Mental health diagnoses were classified using ICD-10-AM codes (International Statistical Classification of Diseases and Related Health Problems-Tenth edition-Australian Modification) and mapping tables were used to recode different editions of ICD codes. Mothers were classified as having a mental health-related hospitalisation or contact if they had a mental health-related ICD diagnosis (primary and/or secondary).

Mental health diagnoses were classified into one of eleven groups using ICD codes: organic disorders, substance-related disorders, schizophrenia, mood disorders, anxiety, personality disorders, intellectual disabilities, disorders of psychological development, intentional self-harm, Other mental health related contacts and Broader mental health related contacts (Appendix A, Table A). The 'Broader' group included contacts that do not meet the specific criteria for a mental health diagnosis, but the principal or secondary diagnosis is related to their health issues. These contacts are considered less severe mental health-related issues than the diagnoses-specific groups. The most prevalent ICD-10 codes found in the 'Broader' group were related to: 'Other problems with housing and economic circumstances' (Z59.8) and 'Personal history of psychoactive substance abuse' (Z86.4). The co-occurrence of these issues and mental health disorders are widely documented in the literature. For example, people with mental health issues are more likely to experience homelessness or not living in a safe and stable place, and overcrowded housing has been related to mental and physical health issues<sup>15 16</sup>. Additionally, there is extensive literature analysing the association between substance use/abuse and mental health issues<sup>17</sup>.

A broad approach was taken to examine the timing of maternal mental health-related contacts, given that child development is influenced by events after birth and those that take place in-utero and prior to conception<sup>18</sup>. For all mothers in the study, we coded whether a mental health contact had occurred proximal to the birth (1 year prior and 1 year post) and a more distal event (up to 5 years prior). It should be noted that the term 'mental health' is used here to describe the diagnoses of mental health and related issues in service settings, and is used here in preference to 'social and emotional wellbeing' (SEWB). Mental health is one aspect of the broader concept of SEWB which we have tried to encapsulate with broader mental health related codes however its scope does not include the aspects of SEWB that pertain to spiritual wellbeing, culture, connection to land and the broader issues that impact on the wellbeing of Aboriginal communities.

#### *Covariates*

Area-level socio-economic status (SES) was measured using the Index of Relative Advantage/Disadvantage 2011 developed by the Australian Bureau of Statistics (ABS). The index ranks the relative level of disadvantage of areas using the attributes of all persons (Aboriginal and non-Aboriginal) in each Statistical Area level 1 (SA1; the smallest area of output for the Australian Census of Population and Housing), and includes measures of income, educational attainment, employment status and occupational skill. Quintiles were determined based on the distribution of values for the total Australian population (for Aboriginal and non-Aboriginal children)<sup>19</sup>.

The 2011 Remoteness Areas (RAs) classification developed by the ABS was used to determine geographical remoteness. The classification divides Australia into broad regions that share common characteristics of remoteness for statistical use. The RAs are based on the Accessibility/Remoteness Index of Australia (ARIA+), and include five categories—ranging from Major cities (Perth metropolitan area), to inner regional, outer regional, remote and very remote areas<sup>20</sup>.

Maternal age at birth was captured by the Birth Registration dataset, which includes information on all births registered in Western Australia, containing information from the mother, father and baby. Maternal age was grouped into four categories: under 20 years old, 20 to 29 years, 30 to 39 years, and over 39 years. This grouping was chosen to ensure there were enough counts within each group and to maximise comparability with a previous study by O'Donnell et al<sup>5</sup> to investigate the relationship between mental health contacts and age at birth. Other research found that younger mothers are more likely to suffer antenatal and post-natal depression, and that Aboriginal women are more likely to be mothers at younger age compared to non-Aboriginal mothers<sup>18</sup>.

### Statistical analysis

The study utilises descriptive and inferential statistical methods to ascertain the scale and change over time of Aboriginal children whose mother had a mental health-related contact 5 years prior to birth, 1 year prior to birth and 1 year post birth. To analyse change over time, a trend analysis was undertaken using a univariate Generalised Linear Model (GLM) with Poisson distribution, log link function and adjusting for the population (births) in each year. Trends are reported as the percentage change in the incidence rate ratios (IRR) for each increase in birth year and their 95% confidence interval (CI).

Univariate and multiple logistic regression modelling were used to analyse factors associated with the odds of Aboriginal children being born to a mother who had a mental health contact, clustering children by mothers, and adjusting by maternal age at birth, remoteness, and SES. Maternal age and SES are typically associated with mental health outcomes in mothers, while service access is likely to differ by geographical remoteness<sup>5 21</sup>.

### Ethical approvals

The study was approved by the Western Australian Aboriginal Health Ethics Committee (reference 416), Murdoch University Human Research Ethics Committee (reference 2014/025) and Western Australian Department of Health WA Human Research Ethics Committee (reference 2014/21).

## 2. Analysis

Of the 43,383 Aboriginal children born in Western Australia between 1990 and 2013, 34% were born to a mother who had a mental health contact 5 years pre-birth or 1 year post-birth. In the cohort overall, 49% were female, the majority (57%) were born to a mother aged 20-29 years, 60% were living in an area within the highest quintile of socio-economic disadvantage, 34% were from a major city and another 40% from a remote/very remote area (Table 1), with similar proportions among Aboriginal children born to a mother with a mental health contact.

**Table 1.** Descriptive statistics of Aboriginal children born between 1990 and 2013. Prevalence of maternal mental health-related contacts.

	Cohort		Aboriginal children born to a mother who had MH contact					
			5 years pre birth		1 year pre birth		1 year post birth	
	N	%	N	%	N	%	N	%
N Aboriginal children	43,383	-	12,043	27.8	6,723	15.5	6,479	14.9
<i>Gender</i>								
Female	21,162	48.8	5,909	49.1	3,291	49.0	3,208	49.5
Male	22,210	51.2	6,130	50.9	3,429	51.0	3,268	50.4
<i>Maternal age at birth</i>								
<20 years	10,385	23.9	2,354	19.5	1,446	21.5	1,403	21.7

1									
2									
3	20-29 years	24,899	57.4	7,036	58.4	3,775	56.2	3,641	56.2
4	30-39 years	7,700	17.7	2,529	21.0	1,429	21.3	1,360	21.0
5	>39 years	396	0.9	124	1.0	73	1.1	75	1.2
6									
7									
8	<i>Socio-economic status*</i>								
9	1 (high disadvantage)	25,831	59.5	7,281	60.5	4,090	60.8	3,915	60.4
10	2	8,295	19.1	2,180	18.1	1,168	17.4	1,149	17.7
11	3	4,189	9.7	1,116	9.3	631	9.4	623	9.6
12	4	2,137	4.9	626	5.2	371	5.5	349	5.4
13	5 (low disadvantage)	1,165	2.7	290	2.4	155	2.3	139	2.1
14									
15									
16	<i>Remoteness*</i>								
17	Major Cities	14,607	33.7	4,424	36.7	2,650	39.4	2,563	39.6
18	Inner Regional	2,254	5.2	526	4.4	288	4.3	260	4.0
19	Outer Regional	6,512	15.0	1,604	13.3	797	11.9	777	12.0
20	Remote	7,894	18.2	1,841	15.3	880	13.1	841	13.0
21	Very Remote	9,690	22.3	2,930	24.3	1,722	25.6	1,653	25.5

\*Note Maternal age, SES and Remoteness sub-totals do not sum 100% due to missing records.

Almost 30% of cohort children were born to a mother with at least one mental health contact in the 5 years prior to birth, with 15% reported in both the year prior and year post birth. The changes in prevalence over time were similar for each of these three indicators, amounting to an average increase of 4-5% per year over the whole 1990-2013 study period (5 years prior to birth: IRR=1.04, CI: 1.03-1.05; 1 year prior to birth: IRR=1.05, CI: 1.03-1.07; 1 year post birth IRR=1.04, CI: 1.03-1.06). The pattern was characterised by relatively large year-on-year increases—of 7-10% per year, on average—that peaked in 2007 (to 410 per 1,000 births for the 5 years prior to birth indicator, and 268 and 247 per 1,000 births for 1 year prior and 1 year post birth, respectively) with subsequent moderate decreases to 2013 (5-6% per year)(Figure 1).

Substance-related disorders, Mood disorders, Anxiety and 'Broader' mental health-related contacts were the most prevalent contact types in the 5 years prior to birth (Figure 2; see Appendix A Table A for diagnoses within the 'Broader' mental health-related contacts category, and Figure A and Figure B for trends by diagnosis type for 1 year prior and 1 year post birth, respectively). The largest change over time was exhibited in the 'Broader' mental health-related category (11% per year over the study period; 95% CI: 1.08-1.15), with small or negligible changes in the other ten groups—for example, an average increase of 1% per year (95% CI: 0.99-1.02) for Substance-related disorders, 3% per year (95% CI: 1.02-1.04) for Anxiety, and 4% per year (95% CI: 1.02-1.06) for Mood disorders.

Broadly speaking, the results consistently highlight small to moderate effects sizes for the associations between SES, remoteness and maternal age on maternal mental health contacts (Table 2). This includes contacts recorded within 5 years, 1 year prior to birth and 1 year post-birth. As a general rule, the pattern and scale of effects for each covariate were similar regardless of when the mental health event was recorded. The pattern of effects for SES was akin to a small threshold effect, with Aboriginal children in all other quintiles at elevated odds of having a maternal mental health contact 5 years prior to birth compared with those in the lowest quintile of disadvantage—although the results only reached statistical significance for the highest quintile of disadvantage (OR=1.21; CI: 1.03–1.43) and second lowest quintile (OR=1.27; CI: 1.04–4.53).

There was no statistically significant difference in the odds of a maternal mental health contact between children from Major Cities (reference group) and those from Very remote areas,



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2  
3 irrespective of the follow up period. Living in Inner Regional areas (OR=0.69 for 5 years prior to birth;  
4 95% CI: 0.60-0.78), Outer Regional areas (OR=0.74; 95% CI: 0.68-0.81) and Remote areas (OR=0.70;  
5 95% CI: 0.64-0.76) was associated with a lower likelihood of maternal mental health contact relative  
6 to those born in Major Cities.  
7

8  
9 Finally, Aboriginal children born to a mother aged over 20 years were at increased odds of having a  
10 maternal mental health contact, both prior and post birth. While the highest odds prior to birth  
11 were for the 30-39 years age group (5 years prior to birth: OR=1.71, CI: 1.57-1.85; 1 year prior to  
12 birth: OR=1.44, CI: 1.31-1.58), after birth the greatest odds were for those born in the over 39  
13 maternal age group (OR=1.45, CI: 1.09-1.92).  
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**Table 2.** Univariate and multiple logistic regression: Odds of having a mother who had a mental health contact 5 years prior birth, 1 year prior birth and 1 year post birth.

		Odds ratio (95% CI)					
		5 Years prior birth		1 Year prior birth		1 Year post birth	
		Univariate	Multivariate	Univariate	Multivariate	Univariate	Multivariate
<i>Socio-economic status (quintiles)</i>							
	1 (high disadvantage)	1.18 (1.02-1.38)*	1.21 (1.03-1.43)*	1.23 (1.03-1.46)*	1.14 (0.94-1.39)	1.32 (1.09-1.59)*	1.31 (1.06-1.62)*
	2	1.08 (0.92-1.26)	1.10 (0.93-2.30)	1.07 (0.89-1.29)	1.01 (0.82-1.23)	1.19 (0.97-1.45)	1.20 (0.96-1.49)
	3	1.10 (0.93-1.29)	1.12 (0.94-3.34)	1.16 (0.95-1.41)	1.08 (0.88-1.34)	1.29 (1.05-1.59)*	1.29 (1.03-1.62)*
	4	1.25 (1.04-1.5)*	1.27 (1.04-4.53)*	1.37 (1.11-1.69)*	1.27 (1.01-1.59)*	1.44 (1.15-1.80)*	1.45 (1.14-1.84)*
	5 (low disadvantage)	Reference	Reference	Reference	Reference	Reference	Reference
<i>Remoteness</i>							
	Major Cities	Reference	Reference	Reference	Reference	Reference	Reference
	Inner Regional	0.70 (0.61-0.80)*	0.69 (0.60-0.78)*	0.66 (0.57-0.76)*	0.65 (0.56-0.75)*	0.61 (0.52-0.72)*	0.61 (0.52-0.71)*
	Outer Regional	0.75 (0.69-0.82)*	0.74 (0.68-0.81)*	0.63 (0.57-0.69)*	0.63 (0.57-0.69)*	0.64 (0.58-0.70)*	0.64 (0.58-0.70)*
	Remote	0.70 (0.64-0.76)*	0.70 (0.64-0.76)*	0.57 (0.52-0.62)*	0.57 (0.52-0.62)*	0.56 (0.51-0.62)*	0.56 (0.51-0.62)*
	Very Remote	1.00 (0.93-1.07)	0.98 (0.91-1.06)	0.98 (0.90-1.05)	0.96 (0.89-1.04)	0.97 (0.89-1.04)	0.96 (0.88-1.04)
<i>Maternal age at birth</i>							
	<20 years	Reference	Reference	Reference	Reference	Reference	Reference
	20-29 years	1.34 (1.26-1.43)*	1.37 (1.29-1.46)*	1.10 (1.03-1.18)*	1.13 (1.05-1.22)*	1.10 (1.02-1.18)*	1.12 (1.04-1.21)*
	30-39 years	1.67 (1.54-1.81)*	1.71 (1.57-1.85)*	1.41 (1.29-1.54)*	1.44 (1.31-1.58)*	1.37 (1.26-1.50)*	1.40 (1.28-1.54)*
	>39 years	1.56 (1.23-1.97)*	1.51 (1.18-1.93)*	1.40 (1.07-1.83)*	1.37 (1.03-1.81)*	1.50 (1.14-1.96)*	1.45 (1.09-1.92)*

\*p<0.05

### 3. Discussion

There was a distinct increase in the prevalence of Aboriginal children born to a mother with a mental health-related contact between 1990 and 2013 (4-5% per year), regardless of whether mental health contacts were measured at 5 years prior to birth, 1 year prior to birth or 1 year post-birth. The overall increasing trend in mental health contacts can potentially be explained by an increase in mental health service provision, in addition to a possible increase in mental health disorders among mothers<sup>22</sup>. Australian Government spending on mental health per capita more than doubled between 1992 and 2011, outstripping spending at the national level, and providing a substantial boost to the mental health workforce<sup>23</sup> and the funding support for General Hospitals, Residential and Ambulatory services, and the non-government sector to deal with mental health issues<sup>23</sup>.

We observed large increases in mental health contacts from 1990, to a peak in 2007 and a subsequent moderate drop in the years to 2013. The change after 2007 could be attributed to the introduction of the Australian Government's *Better Access to Mental Health* initiative in November 2006<sup>24</sup>. This initiative included additional Medicare items for psychological services for people with mental health disorders, and enabled affordable access to mental health care, including private clinics and practitioners. This may have diverted patients from public hospitals and mental health services to the private sector or Aboriginal Medical Services, which would not have been captured in our data.

The overall contact rates affirm that mental health issues place a considerable burden on Aboriginal Australia, and are of a higher magnitude than that experienced in non-Aboriginal populations<sup>25</sup>. A recent study by O'Donnell et al.<sup>5</sup> highlighted that 1.7% of mothers had a mental health contact in the year before birth in 2005; this compares with 26.7% of Aboriginal mothers in this study<sup>5</sup>. The deleterious effects of the unique post-colonial history of Aboriginal Australia is now well understood, and include issues of dispossession, exclusion, discrimination and marginalisation that have had a profoundly negative impact on the social and emotional wellbeing of Aboriginal people<sup>26</sup>. The stress associated with racial discrimination has, increasingly, been shown to affect the mental wellbeing of a substantial proportion of Aboriginal people in various, often complex ways<sup>27 8</sup>. In addition to the direct effects of interpersonal racism on wellbeing, they include the indirect effects that stem from reduced and unequal access to the range of medical, health promotion and other resources that are required for good family planning and pregnancy health, and the downstream consequences of withdrawing from health care<sup>28 29</sup>.

There was a consistent 2-fold difference between the prevalence of mental health contacts in the period 5 years prior to birth and 1 year prior (Figure 1). This suggests that many of the mental health issues that women develop earlier in life are chronic and complex at the time of conception, during pregnancy and at birth and speaks to the complexities of accumulated and transgenerational trauma that can manifest with a significant life event such as pregnancy and childbirth<sup>30</sup>. Concomitantly, given the large proportion of mothers with a contact in the year pre- and post-birth, the results reinforce that the period of pregnancy and early motherhood, crucial for children's early development, are also critical periods for the mental health care of mothers. Early intervention and support for women with a trauma informed lens in the earliest stages of family planning are required to alleviate the burden of mental health issues at and after birth. Previous research has highlighted the need for policies directed to the development of an holistic health care model, with a multisector approach, offering culturally appropriate services for Aboriginal people, capable of identifying and addressing the complex set of risk factors these mothers, children and families are facing<sup>2 9 31 32 33</sup>.

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3 As mentioned earlier, the child can be affected directly by their mother's mental illness by  
4 intrauterine exposure to depression or anxiety, and after birth through direct exposure to parental  
5 mental illness, as postnatal depression. Previous research has found that 10-13% of pregnant  
6 woman experienced antenatal depression and anxiety<sup>34</sup>, and over 14% may experience postnatal  
7 depression<sup>35</sup>. If these mental health issues are also associated with drug and alcohol use during  
8 pregnancy, domestic violence, and pre-existing mental health problems, the mental health of the  
9 mother, child and family may also be affected<sup>36</sup>. For many Aboriginal mothers, especially for those  
10 living in remote/very remote areas, giving birth away from country, family members and traditional  
11 ways of birthing may also cause additional stress on them and their child which could affect the  
12 child's future development<sup>33</sup>. Parental mental illness can affect the cognitive, emotional, social and  
13 behavioural development of the child, and therefore the literature highlights the importance of early  
14 intervention<sup>3</sup>.  
15  
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17

18 We observed little change in the prevalence of diagnosis-specific contacts—including the more  
19 prevalent categories of Substance-related disorders, Anxiety and Mood disorders—despite the  
20 introduction of policies to provide better support for highly vulnerable Aboriginal populations. The  
21 increase seen on the prevalence of Substance related disorders contacts between 1990 and 1992  
22 (Figure 2) were similar to the findings by O'Donnell et al<sup>37</sup>, stating an increase on substance use in  
23 mothers during pregnancy in the same period. The sharp increase in prevalence seen from 1997-  
24 1998 in the 'Broader' disorder category, together with the small rise in Anxiety and Mood disorders  
25 contacts, can be attributed to an increase in service utilisation. Lawrence et al found a significant  
26 increase in mental health service use from 1998, together with a small increase in major  
27 depression<sup>38</sup>. In the same line, Xu et al found an increase in psychiatric disorders hospitalisation in  
28 the first year after birth, mainly driven by the increase in depression and anxiety disorders<sup>39</sup>. Finally,  
29 reductions were found for 'Broader' mental health diagnoses after 2007, which may reflect a  
30 reduction in less severe mental health related contacts among mothers and/or that the *Better*  
31 *Access to Mental Health* initiative has been effective in providing the opportunity for broader access  
32 to private clinics and practitioners for treatment of these problems.  
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37 Older maternal age was associated with a higher likelihood of maternal mental health-related  
38 contacts among Aboriginal children. This finding is in contrast to a recent study of all Western  
39 Australian mothers, which showed an increased burden among teenagers<sup>5</sup>. Pregnant Aboriginal  
40 women over 30 years of age may have greater caring responsibilities, on average, given the distinctly  
41 higher fertility rates at younger ages among Aboriginal women<sup>40</sup>. This may create extra stress during  
42 pregnancy and potentially exacerbate existing social and emotional difficulties. The finding,  
43 however, is also distinct from the typical age profile of mental health issues among Aboriginal  
44 women more broadly<sup>41</sup>, which may reflect a different pattern of socioeconomic and living  
45 circumstances among Aboriginal women giving birth in their 30s and 40s.  
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### 49 3.1. Limitations

50 Mental health-related issues captured in this study are those related to hospitalisations (HMDC) and  
51 contacts with mental health services (MHIS), with diagnoses classified using ICD-10-AM codes.  
52 However, it is important to mention that not all people with mental health issues have been  
53 diagnosed or are receiving assistance for their condition—accordingly, our results under-estimate  
54 the scale of mental health problems in mothers of Aboriginal children. This is particularly pertinent  
55 to those living in rural and remote areas, where there may be limited or no access to mental health  
56 services. Furthermore, given the diverse landscape of mental health services in WA, mental health  
57 services captured in this study did not include contacts with GPs, private practitioners (psychiatry,  
58 psychology) and Aboriginal Medical Services. This may have limited the type of mental health issues  
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3 captured in our data. Hospitalisation and mental health service contacts might capture more severe  
4 conditions as in many cases, patients reach these services following referral from primary services.  
5 Due to issues of under-ascertainment of mental health issues we have utilised primary and  
6 secondary diagnoses to ascertain mental health-related contacts however it should be noted that  
7 secondary diagnoses are captured inconsistently.  
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9  
10 As mentioned in Section 2, the spatial or geographical distribution of the population was measured  
11 using the variable Remoteness Areas (RAs) developed by ABS, based on information from the 2011  
12 Australian Census of Population and Housing. First, it should be noted that the prevalence estimates  
13 by geographical area are not reflective of the distribution of health or mental health services but the  
14 actual area of residence of each individual. Second, the 2011 RAs may not have always accurately  
15 reflected the individual geographical location at birth, due to changes in classification over time or  
16 individuals moving from one area to another.  
17

18  
19 This study does not intend to evaluate the “Better Access” initiative. The datasets used do not allow  
20 us to differentiate between consumers of the “Better Access” program from those who didn’t.  
21 Additionally, information on private consults for mental health issues with GP or private clinics such  
22 as Aboriginal Medical Services was not available. A full evaluation of the program was developed by  
23 the University of Melbourne in 2011<sup>42</sup>.  
24

#### 25 **4. Conclusion**

26  
27 This study found that 34% of Aboriginal children born in Western Australia between 1990 and 2013  
28 did so to a mother who had at least one mental health-related contact within the 5 years prior to  
29 birth or 1 year post-birth. This prevalence doubled the proportion of Aboriginal children born to a  
30 mother with mental health-related contacts 1 year pre and 1 year post berth, both at 15%. Overall,  
31 the trend analysis was characterised by a steady yearly increase in mental health-related contacts (7-  
32 11% per year) to a peak 2007, when the prevalence declined (5-6% per year) until 2013. The most  
33 prevalent diagnoses types were Substance-related disorders, Mood disorders, Anxiety and ‘Broader’  
34 mental health-related contacts. However, the overall trend seemed to be driven by the ‘Broader’  
35 category.  
36

37  
38 Living in a more disadvantage area was associated with increased risk of being born to mother with a  
39 mental health-related contact irrespective of the follow up period. Interestingly, there was no  
40 statistically significant difference between being born in a Major City or in a Very Remote area,  
41 however, being born either in Regional and Remote areas reduced the risk of a mental health-  
42 related contact. Finally, Aboriginal children born to an older mother were more likely to have a  
43 mother with a mental health-related contact than other children.  
44

45  
46 The findings of this study not only expose the burden of mental health-related contact in Aboriginal  
47 mothers, also indicates the increased risk Aboriginal children face in terms of the impact of mental  
48 health on maternal attachment and coping. The multiple and interrelated disadvantage which  
49 influence the health and wellbeing of Aboriginal children have an impact on their development<sup>17</sup>,  
50 highlighting the need for early intervention and targeted policies. Early intervention and culturally  
51 sensitive support for women in the earliest stages of family planning are required to reduce the  
52 burden of mental health issues at and after birth. There is a clear need for policies directed to the  
53 development of an holistic health care model, with a multisector approach, and, importantly,  
54 offering culturally appropriate services for Aboriginal people.  
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## 5. Acknowledgments

We gratefully acknowledge the Western Australian Data Linkage Branch (Western Australian Government Department of Health) and the government agencies for providing data for this project. This paper does not necessarily reflect the views of the government departments involved in this research.

## 6. Funding statement

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## 7. Authors contributions

All authors (FL CCJS JW MO RM) made a substantial contribution to the study concept and design, and interpretation of the data. FL and JW executed the statistical analyses. FL and CCJS drafted the manuscript. All authors revised the draft critically for important intellectual content, and have approved the final version of the manuscript.

## 8. Data shearing statement

The authors do not have permission to share the data used in this project, which were provided by the Data Linkage Branch of the Western Australian Government Department of Health under strict conditions.

## 9. Competing interest statement

All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

## 10. Patient and Public Involvement statement

Direct PPI was not applicable to this study given that it utilised de-identified linked administrative data. This research has approval from the Western Australian Aboriginal Health Ethics Committee (reference 416), Murdoch University Human Research Ethics Committee (reference 2014/025) and Western Australian Department of Health WA Human Research Ethics Committee (reference 2014/21). The study was also overseen by Prof. Rhonda Marriott, who has strong matrilineal connections to Nyikina people of the Kimberley. This ensured that the design, development and analysis of the research incorporated Indigenous views and advice.

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3 **Figure 1.** Prevalence of Aboriginal children born to a mother who had a mental health related  
4 contact 5 years prior to birth, 1 years prior to birth and 1 year post birth, by year of birth 1990-2013.  
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7 **Figure 2.** Prevalence of children whose mother had a mental health related contact within 5 years  
8 prior to birth, by year of birth and diagnosis type.  
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10 **Appendix. Figure A.** Prevalence of children whose mother had a mental health related contact  
11 within 1 year prior to birth, by year of birth and diagnosis type.  
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14 **Appendix. Figure B.** Prevalence of children whose mother had a mental health related contact  
15 within 1 year post birth, by year of birth and diagnosis type.  
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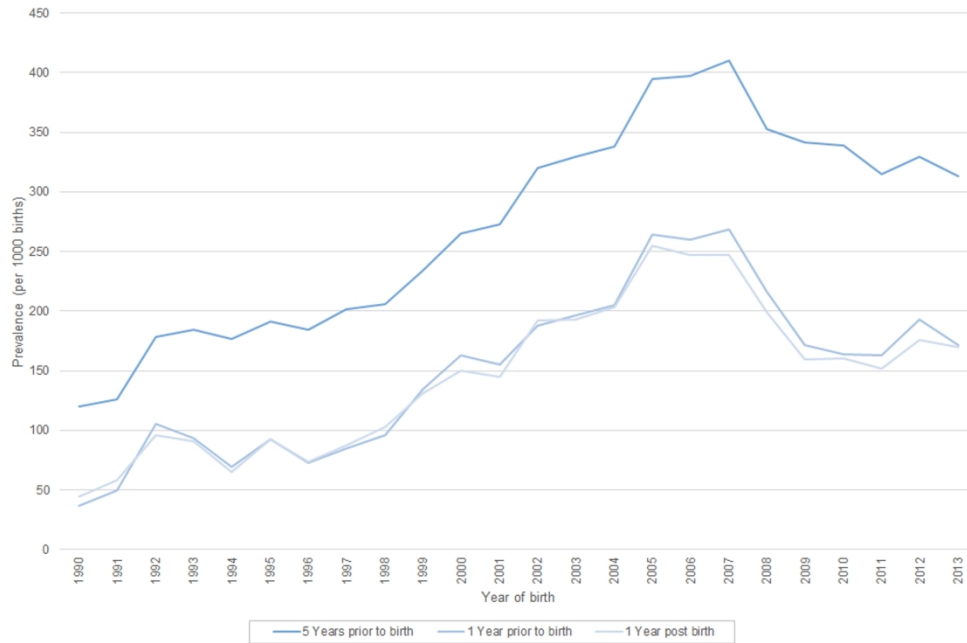


Figure1. Prevalence of Aboriginal children born to a mother who had a mental health related contact 5 years prior to birth, 1 years prior to birth and 1 year post birth, by year of birth 1990-2013.

330x215mm (300 x 300 DPI)

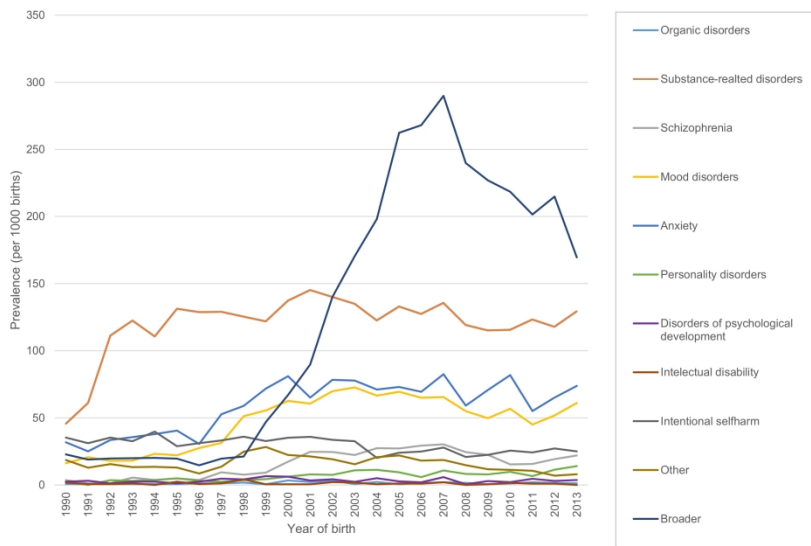


Figure 2. Prevalence of children whose mother had a mental health related contact within 5 years prior to birth, by year of birth and diagnosis type.

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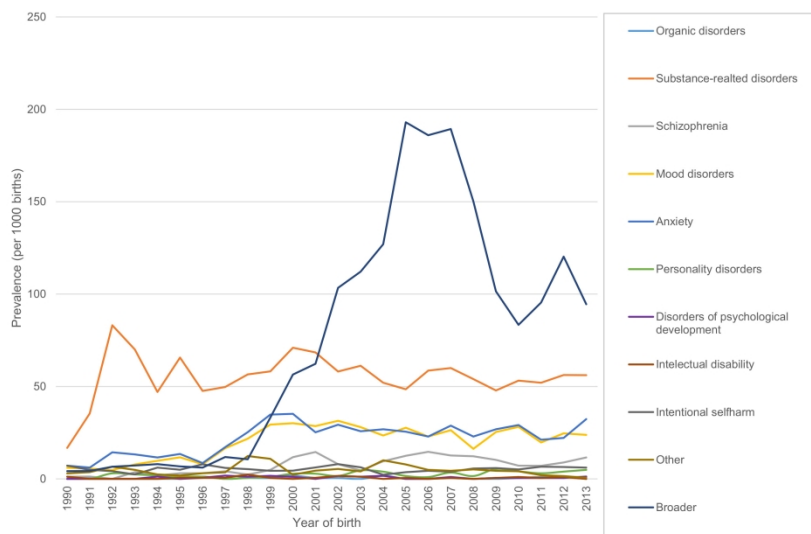


Figure A. Prevalence of children whose mother had a mental health related contact within 1 year prior to birth, by year of birth and diagnosis type.

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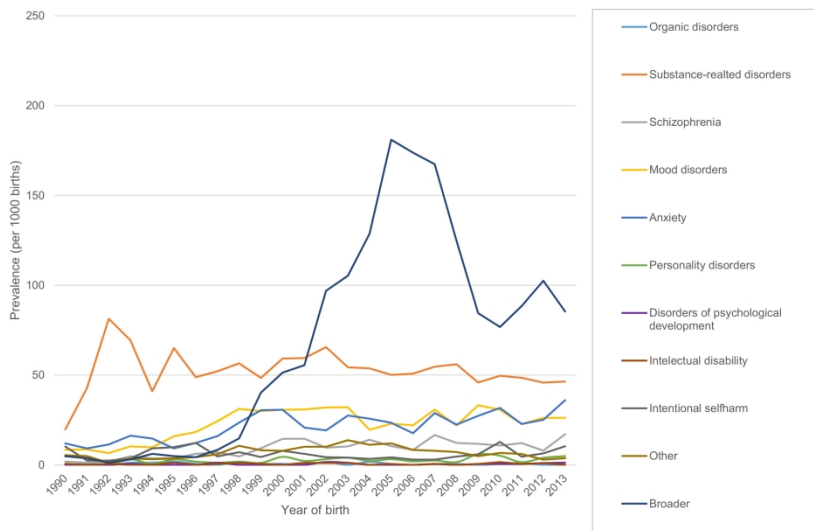


Figure B. Prevalence of children whose mother had a mental health related contact within 1 year post birth, by year of birth and diagnosis type.

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- **Appendix A**

**Table A.** Mental health related diagnoses groups.

Mental Health disorders	ICD-9-CM	ICD-10-AM
Organic disorder	290, 293, 294, 310	F00-F09, G30
Substance-related disorder	291, 292, 303, 304, 305	F10-F19, F55
Schizophrenia	295, 296, 297, 298	F20-F29, F33.3, F30, F31, F32.1-F32.8, F33.1-F33.9, F34.8, F34.9, F38, F39
Mood disorder	296, 300.4, 311,	F32.0, F32.9, F33.0, F34.1
Anxiety	300.0, 300.2, 300.3, 300.8, 308, 309	F40-F43, F45, F48, F63.3, F68
Personality disorder	301	F60, F61, F62, F68.1, F68.8, F69
Intellectual disability (IQ)	317, 318, 319	F70-F79
Disorders of psychological development	299, 307.2, 307.3, 307.6, 307.7, 312, 313, 314, 315	F80-F89, F90-F98
Intentional self-harm	E950-E959	X6, X7, X80-X84
Other mental health related contacts	300.5, 300.6, 300.7, 300.9, 302, 306, 307.0, 307.1, 307.4, 307.5, 307.8, 307.9, 310, 316	F44, F48, F50, F51, F52, F53, F54, F59, F63, F64, F65, F66, F95, F98, F99
Broader mental health related contacts	368.1, 799.2, V11, V15.4, V40, V66.3, V67.3, V70.1, V70.2, V71.0, V79	G30, R44, R45, R46, R47, R48, Y10-Y34, Z00.4, Z03.2, Z04.6, Z09.3, Z13.3, Z50.2, Z50.3, Z50.4, Z54.3, Z56, Z59-Z65, Z70, Z71.4, Z71.5, Z71.6, Z71.9, Z86.4, Z86.5, Z91.4, Z91.5

**Figure A.** Prevalence of children whose mother had a mental health related contact within 1 year prior to birth, by year of birth and diagnosis type.

**Figure B.** Prevalence of children whose mother had a mental health related contact within 1 year post birth, by year of birth and diagnosis type.

# Reporting checklist for cohort study.

Based on the STROBE cohort guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cohort reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title	<a href="#">#1a</a>	Indicate the study's design with a commonly used term in the title or the abstract	0
Abstract	<a href="#">#1b</a>	Provide in the abstract an informative and balanced summary of what was done and what was found	1

1	Background / rationale	<a href="#">#2</a>	Explain the scientific background and rationale for the investigation being reported	2-3
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5	Objectives	<a href="#">#3</a>	State specific objectives, including any prespecified hypotheses	2-3
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9	Study design	<a href="#">#4</a>	Present key elements of study design early in the paper	3
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13	Setting	<a href="#">#5</a>	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
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17	Eligibility criteria	<a href="#">#6a</a>	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up.	2-3
18				
19		<a href="#">#6b</a>	For matched studies, give matching criteria and number of exposed and unexposed	n/a
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21	Variables	<a href="#">#7</a>	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2-3
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25	Data sources / measurement	<a href="#">#8</a>	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	2-3
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29	Bias	<a href="#">#9</a>	Describe any efforts to address potential sources of bias	9
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33	Study size	<a href="#">#10</a>	Explain how the study size was arrived at	
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1	Quantitative variables	<a href="#">#11</a>	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	2-3	
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8	Statistical methods	<a href="#">#12a</a>	Describe all statistical methods, including those used to control for confounding	2-3	
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13		<a href="#">#12b</a>	Describe any methods used to examine subgroups and interactions	2-3	
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16		<a href="#">#12c</a>	Explain how missing data were addressed	n/a	
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18		<a href="#">#12d</a>	If applicable, explain how loss to follow-up was addressed	n/a	
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20		<a href="#">#12e</a>	Describe any sensitivity analyses	n/a	
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22	Participants	<a href="#">#13a</a>	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	2-3	
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26		<a href="#">#13b</a>	Give reasons for non-participation at each stage	n/a	
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28		<a href="#">#13c</a>	Consider use of a flow diagram	n/a	
29					
30	Descriptive data	<a href="#">#14a</a>	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5-7	
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6		<a href="#">#14c</a>	Summarise follow-up time (eg, average and total amount)	n/a
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10	Outcome data	<a href="#">#15</a>	Report numbers of outcome events or summary measures	5-7
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17		<a href="#">#16a</a>	Give unadjusted estimates and, if applicable, confounder-	5-7
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27		<a href="#">#16b</a>	Report category boundaries when continuous variables were	5-7
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38	Other analyses	<a href="#">#17</a>	Report other analyses done—e.g., analyses of subgroups	13-14
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43	Key results	<a href="#">#18</a>	Summarise key results with reference to study objectives	5-7
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46	Limitations	<a href="#">#19</a>	Discuss limitations of the study, taking into account sources	9-10
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1	Interpretation	<a href="#">#20</a>	Give a cautious overall interpretation considering objectives,	5-7
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3			studies, and other relevant evidence.	
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8	Generalisability	<a href="#">#21</a>	Discuss the generalisability (external validity) of the study	n/a
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14	Funding	<a href="#">#22</a>	Give the source of funding and the role of the funders for the	10
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