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ORIGINAL ARTICLE

Policy Impacts of the Australian National Perinatal Depression Initiative: Psychiatric Admission in the First Postnatal Year

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Abstract

This paper helps to quantify the impact of the Australian National Perinatal Depression Initiative (NPDI) on postnatal inpatient psychiatric hospitalisation. Based on individual hospital admissions data from New South Wales and Western Australia, we found that the NPDI reduced inpatient psychiatric hospital admission by up to 50% [0.9% point reduction (95% CI 0.70–1.22)] in the first postnatal year. The greatest reduction was observed for adjustment disorders. The NPDI appears to be associated with fewer post-birth psychiatric disorders hospital admissions; this suggests earlier detection of psychiatric disorders resulting in early care of women at risk during their perinatal period.

Keywords Perinatal depression initiative · Depression · Psychiatric disorders · Policy analysis

Abbreviations

CI	Confidence interval
NPDI	National perinatal depression initiative
NSW	New South Wales
PD	Psychiatric disorders
SEIFA	Socio-economic indexes for area
T1	First treatment group
T2	Second treatment group
UK	United Kingdom
WA	Western Australia

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Background

Perinatal depression is a neglected global health priority, affecting 10–15% of women in developed countries and a greater proportion in developing countries. Given the growing policy and public health interest in the identification and treatment of perinatal depression, an understanding of

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the implications of the implementation of a routine universal screening program is crucial. This study quantifies the impact of the Australian National Perinatal Depression Initiative (NPDI), an initiative announced in the 2008–2009 Australian federal government budget. It involved universal routine screening of perinatal women using the Edinburgh Postnatal Depression Scale and providing follow up support and care. In addition, a number of free perinatal-specific counselling sessions (under the Access to Allied Therapeutic Services) were introduced nationally in early 2009 for more economically disadvantaged perinatal women with a mild to moderate psychiatric diagnosis (PD). Furthermore, each jurisdiction was to fund perinatal mental health clinicians to provide and coordinate specialist clinical services to perinatal women at the local health service level. While availability of psychiatric beds is scarce in Australia (Allison and Bastiampillai 2015) there were no policy changes in terms of bed availability, occurring around the time of the introduction of the NPDI that might have confounded rates of postnatal admissions, over the study period. Availability of public mother baby beds varies by jurisdiction, and in New South Wales (the most populous Australian state which provided most of the data for this study) the lack of such beds did not change over the study period.

There are no comparable perinatal depression initiatives or policies in other countries with which to contrast our findings. While the British (NICE 2014) and Scottish (SIGN 2012) clinical practice guidelines both recommend that perinatal women be routinely asked about past and family psychiatric history, and that those with such history be further interviewed for current symptoms, neither have recommended the universal screening approach that Australia has taken.

The perinatal period, defined as the time from conception to the end of the first postnatal year, is associated with an increased risk of early postnatal admission with more severe PD, in particular mood disorders (whether new or relapsing) and puerperal psychosis (Munk-Olsen et al. 2006). PD in the perinatal period result in significant distress, can disrupt the developing bond between mother and child, and have long-term implications for the wellbeing of the woman, the baby, her family, and wider society (Jones et al. 2014). The recognition and treatment of perinatal PD is important not least because suicide is a major cause of maternal deaths in high-income countries (Cantwell et al. 2011). Previous studies from Denmark, the UK and the US have estimated post-partum admission rates (within 3 months of delivery) to psychiatric hospitals to be about 1–2 per 1000 births in the general population (Kendell et al. 1987; Terp and Mortensen 1998; Vesga-López et al. 2008). In Australia, it is estimated that about 2% of mothers were admitted to hospital with a principal diagnosis of PD in the first year after birth between 2001 and 2010 in New South Wales (Xu et al. 2014). Long term economic costs are estimated to exceed £8b for each annual cohort in the UK and there have been calls for the UK government to spend about £340 m a year to bring perinatal PD care up to the level recommended in national guidance (Bauer et al. 2014).

Since 2008 a number of policy initiatives aimed at reducing PD in the perinatal period have been introduced in Australia. In March 2008, a collaboration of State and Territory Governments and the Australian Government agreed to develop a NPDI. Key elements of the NPDI included routine and universal screening for perinatal depression using the Edinburgh Postnatal Depression Scale, follow up support and care for women assessed as being at risk of or experiencing perinatal depression, workforce training and development for health professionals, national guidelines for screening for perinatal depression, and increasing community awareness (Austin et al. 2010). Formal guidelines for perinatal mental health care consistent with the aims of the NPDI were released by *Beyondblue* (2011). In the NPDI policy implementation, no universal, systematic data collection or evaluation processes were specifically conducted to examine the impacts of the policy.

The key objective of this study, was to examine the impact of the NPDI on inpatient psychiatric hospitalisations in the first postnatal year, to address the hypothesis that increased screening and follow-up care (as per the NPDI) will lead to changes in admissions rates of PD for mothers in the postnatal period. One expected outcome of the NPDI is that more screenings for antenatal and postnatal depression would be conducted using the Edinburgh Postnatal Depression Scale (to detect possible symptoms) together with a psychosocial risk assessment (to identify those women at greater risk of developing perinatal mental health conditions in the perinatal period). Furthermore, the corresponding effects of routine screening (an increased awareness of symptoms, prompt referral to information, support and treatment services) together with an increased awareness on mental health service uptake, including inpatient hospitalisations, have not been examined. Early detection (and treatment) could lead to less escalation in episode severity and fewer hospital admissions. Alternatively, increased awareness might lead to greater case detection and increased hospital admissions for more severe cases. It has been previously estimated that up to 50% of all cases with postnatal depression episodes go undetected (Gale and Harlow 2003). It remains an empirical question as to whether the NPDI is associated with an increase, decrease, or no change in the rate of postnatal psychiatric hospitalization. We test for the hypothesis that the impact of the NPDI on PD admissions is non-zero.

Methods

Data Sources

NSW Midwives Data Collection and WA Midwives Notification System

All women residents in New South Wales (NSW) and Western Australia (WA) who gave birth in the period 1st July 2000 to 31st December 2009 were identified through the NSW Midwives Data Collection and WA Midwives Notification System. Both these databases report all births at least 20 weeks gestation or at least 400 g birth weight.

NSW Admitted Patients Data Collection and WA Hospital Morbidity Data Collection

Mental health morbidity (hospital admissions) was examined for the period 1st July 1999 to 31st December 2010 using inpatient admissions for NSW and WA. In NSW, perinatal status from the Midwives Data Collection is merged to the Admitted Patients Data Collection (APDC) and in WA, the perinatal status is merged to the WA Hospital Morbidity Data Collection. The study population includes all inpatient hospitalisations in NSW and WA public and private hospitals and day surgery hospitals. At discharge, records contain diagnosis codes, from one up to 55 different codes. Probabilistic record linkage to link the birth information to the hospital records was performed by the NSW Centre for Health Record Linkage (CHeREL) and the WA Data Linkage Branch (WADLB).

We focus on the principal ICD-10-AM diagnosis code for identifying hospital admissions for PD. The study excludes women aged < 16 years and > 44 years at the time of first birth in the study period, and women who gave birth to twins or higher order multiples. It is also restricted to the first observed birth for a woman during the study period (which is not necessarily the first birth).

Study Design

Given that the NPDI was announced in the 2008–2009 Australian federal government budget and a lack of publicly available data relating to rates of uptake of the NPDI at national or state levels (Austin et al. 2012), we used January 2009 as an unofficial start date of the NPDI for the current policy impact analysis. There is no single start date of the program that policy makers agree upon, since it was implemented gradually across all states. This cut-off date was based on expert advice from the study investigators and a 2012 survey (unpublished) undertaken of state and territory representatives under the NPDI (Highet and Purtell 2012).

As the NPDI was implemented nationally, a practical difficulty in evaluating the policy effects of the NPDI is that no state or local areas can be used as a control group in a standard difference-in-differences design. A further complication in evaluating the NPDI is that alongside the introduction of the NPDI there have been numerous other mental health policy initiatives over the last decade. For example, the National Postnatal Depression Program (2001–2005) increased awareness of perinatal mental illness in health professionals and perinatal women through screening and education. More recently, the 'Better Access to Mental Health Care' scheme introduced in November 2006 led to a significant increase in access to, and utilisation of, Medicare funded mental health care (Pirkis et al. 2011).

In this study, we adopt an approach often referred to in the clinical trials literature as a historical control group design (Watts et al. 2003; French et al. 2010). A historical control can be defined as the expected behavior of a cohort of individuals based on their past behavior as can be reproducibly demonstrated in historical data (i.e. a study population with predictable results). In the clinical trials literature, when making inference from historical controls, one typically compares the new treatment in a current series of patients with control group patients studied in previous clinical trials.

In our context where the NPDI was implemented nationwide, a comparison is made of a cohort of perinatal women at a later time with a cohort of perinatal women at an earlier time using as an intervention the availability of the NPDI. Here, the comparison is in the different policy environments between two different periods (NPDI vs. non-NPDI).

In our study design, we employ the use of two treatment groups that are paired with several control groups. The first treatment group (T1) comprises of all women aged 16–44 in NSW and WA who gave birth in the period 1st Jan 2009 to 30th June 2009. The second treatment group (T2) comprises women who gave birth between 1st July 2009 and 31st December 2009. The reason we choose to split our treatment groups in this fashion is because while January 2009 is the nominal start date for the empirical analysis, as the policy was gradually phased in, it is possible that mothers giving birth in the later part of 2009 experienced more services as a result of the NPDI.

For the control groups, we use various cohorts of women aged 16–44 in NSW and WA who gave birth in the recent period 1st January 2007 to 30th December 2008. In order to control for possible calendar month effects, we pair T1 mothers with control group mothers giving birth between 1st Jan and 30th June and T2 mothers with control group mothers giving birth between 1st July and 31st December.

The focus on only the more recent historical controls is deliberate, ensuring that both the treatment and control group were under the 'Better Access' environment in Australia. More recent historical controls also allow for there to be fewer possible influences over time due to changes in the economic environment. Although the 2008–2009 period includes the Global Financial Crisis (GFC), the effect of the crisis on Australia has been considerably less than in many other countries. The Australian economy has recorded markedly better growth outcomes than most other developed economies, many of which experienced severe recessions and increases in the unemployment rate (Debelle 2009). As such, we do not expect the GFC to have any confounding effects on PD hospitalisation rates for perinatal women and our estimates of the impacts of the NPDI.

Outcomes

PD was flagged if any ICD10-AM code in the principal diagnosis was between F00 and F99. The following categories of PD were specifically examined: Schizophrenia, schizotypal and delusional disorders—F20–F29; unipolar depression—F32 (depressive episode), F33 (recurrent depressive disorder), F34.1 (dysthymia), F38.8 (other specified mood [affective] disorders), F39.0 (unspecified mood [affective] disorder); bipolar—F30 (manic episode), F31 (bipolar affective disorder), F34.0 (Persistent mood [affective] disorders), F38.0 (other single mood [affective] disorders, mixed affective episode); Adjustment—F43 (reaction to severe stress, and adjustment disorders); puerperal—F53 (mental and behavioural disorders associated with the puerperium, not elsewhere classified); other—F00–F99 not listed above.

The outcomes examined are PD admission (any or specific type) within 30 days, 60 days, 120 days, 180 days and 360 days of birth.

Statistical Analysis

In the absence of a randomised experiment, the goal of matching a control group to a treatment group is to achieve as much overlap of the two groups as possible in order to minimise any initial non-equivalence of the two groups. Inference from the use of historical controls may be subject to a strong selection bias (Gehan 1984). While the cohort of women in NSW and WA giving birth just before and just after the introduction of the NPDI should resemble each other in terms of their individual characteristics, we can ensure this further by using a statistical matching approach. Propensity score methods are increasingly being used to estimate the effects of treatments on health outcomes using observational data. They are widely regarded as useful tools in program evaluation and are gaining popularity in fields such as economics, epidemiology, medicine and political science (Stuart 2010).

To estimate the average 'treatment' effects of the NPDI on inpatient psychiatric hospitalisations in perinatal women, we employ doubly robust estimation which combines outcome regression with inverse probability weighting by the estimated propensity score (Bang and Robins 2005; Funk et al. 2011). When used individually to estimate the impact of a policy, both regression and propensity score methods are unbiased only if the statistical model is correctly specified. The doubly robust estimator combines these two approaches such that only one of the two models needs to be correctly specified to obtain an unbiased estimate of the average treatment effect.

To control for confounding factors, several characteristics of mothers were included in the statistical model. Covariates that are measured at the time of first observed birth and included in the multivariate analysis include: mother's age (in years) and age squared, marital status, insurance status, jurisdiction and a socio-economic index based on local geographical areas (based on data from the 2006 Australian Census and collapsed into quintiles to represent five basic socio-economic levels).

As data on the history of any prior PD hospital admissions prior to giving birth is important in helping us determine the likelihood of postnatal PD hospital admissions (Patton et al. 2015), we also include variables to control for any PD admissions prior to birth. Specifically, we include variables to indicate any PD hospital admissions 0–90 days before, 90–180 days before, 180–270 days before, 270–360 days before, 1–2 years before, 2–3 years before, 3–4 years before, 4–5 years before, 5–6 years before, and 6–7 years before birth.

Given our interest in comparing PD hospital admission rates between women exposed and not exposed to the NPDI during the perinatal period, the relevant metric of time in our study is not calendar time, but instead time before or after giving birth. All analyses were performed using Stata SE version 14.1 (Stata Corp., College Station, Texas, USA, 2015).

Results

The characteristics of the unmatched treatment and comparison groups are provided in Table 1. The appropriateness of the use of historical controls in our study design is readily apparent. Means of the characteristics of T1 mothers are provided in column 1, while columns 2–3 provide the means for the relevant comparison groups. A comparison of the means suggests that even prior to any statistical adjustment using matching, there are already many close similarities in mothers giving birth pre- and post-NPDI. The same observation applies to comparing T2 mothers (column 4) with their comparison groups (columns 5–6). This is important

Table 1 Characteristics of the unmatched treatment and comparison groups

Characteristic	Treatment Group T1 (Jan–Jun 2009 births)	Comparison Group (Jan–Jun 2008 births)	Comparison Group (Jan–Jun 2007 births)	Treatment Group T2 (Jul–Dec 2009 births)	Comparison Group (Jul–Dec 2008 births)	Comparison Group (Jul–Dec 2007 births)
Mother's age	29.529 (5.791)	29.583 (5.934)	29.695 (5.854)	29.563 (5.758)	29.684 (5.880)	29.717 (5.806)
Single	0.223 (0.416)	0.211 (0.408)	0.200 (0.400)	0.223 (0.416)	0.215 (0.411)	0.201 (0.401)
Divorced/widowed/separated	0.012 (0.109)	0.013 (0.114)	0.014 (0.118)	0.010 (0.100)	0.013 (0.115)	0.014 (0.119)
Has insurance	0.358 (0.479)	0.344 (0.475)	0.343 (0.475)	0.387 (0.487)	0.350 (0.477)	0.344 (0.475)
SEIFA quintile 2	0.215 (0.411)	0.212 (0.409)	0.213 (0.410)	0.208 (0.406)	0.214 (0.410)	0.210 (0.407)
SEIFA quintile 3	0.248 (0.432)	0.253 (0.435)	0.248 (0.432)	0.256 (0.436)	0.250 (0.433)	0.242 (0.429)
SEIFA quintile 4	0.189 (0.392)	0.187 (0.390)	0.180 (0.384)	0.198 (0.399)	0.188 (0.391)	0.186 (0.389)
SEIFA quintile 5	0.215 (0.411)	0.209 (0.407)	0.216 (0.412)	0.230 (0.421)	0.215 (0.411)	0.218 (0.413)
PD admission 0–90 days before birth	0.000 (0.022)	0.000 (0.021)	0.001 (0.027)	0.000 (0.022)	0.001 (0.025)	0.001 (0.025)
PD admission 90–180 days before birth	0.001 (0.027)	0.001 (0.030)	0.000 (0.021)	0.001 (0.031)	0.001 (0.025)	0.001 (0.029)
PD admission 180–270 days before birth	0.001 (0.031)	0.001 (0.035)	0.001 (0.032)	0.001 (0.035)	0.001 (0.035)	0.001 (0.026)
PD admission 270–360 days before birth	0.002 (0.041)	0.001 (0.036)	0.001 (0.037)	0.001 (0.034)	0.001 (0.039)	0.001 (0.038)
PD admission 1–2 years before birth	0.005 (0.069)	0.006 (0.076)	0.005 (0.071)	0.005 (0.070)	0.005 (0.073)	0.005 (0.070)
PD admission 2–3 years before birth	0.005 (0.071)	0.006 (0.076)	0.004 (0.061)	0.004 (0.064)	0.005 (0.069)	0.004 (0.063)
PD admission 3–4 years before birth	0.004 (0.063)	0.003 (0.054)	0.004 (0.063)	0.005 (0.068)	0.003 (0.057)	0.003 (0.057)
PD admission 4–5 years before birth	0.003 (0.053)	0.004 (0.059)	0.003 (0.058)	0.003 (0.057)	0.003 (0.058)	0.004 (0.061)
PD admission 5–6 years before birth	0.002 (0.048)	0.003 (0.054)	0.003 (0.055)	0.002 (0.050)	0.003 (0.051)	0.003 (0.051)
PD admission 6–7 years before birth	0.003 (0.050)	0.003 (0.057)	0.002 (0.048)	0.002 (0.047)	0.003 (0.055)	0.003 (0.050)
NSW	0.745 (0.436)	0.747 (0.435)	0.758 (0.428)	0.733 (0.443)	0.750 (0.433)	0.780 (0.414)
N	25,361	24,388	26,296	25,466	24,749	24,825

Standard deviations in parentheses

PD psychiatric disorders, *SEIFA* socio-economic indexes for areas, *NSW* New South Wales

because comparing the treatment group with comparison groups that are very similar in observed characteristics help create a better policy counterfactual.

Table 2 presents the frequencies of PD hospital admissions for T1 and T2 mothers. For T1 mothers, 2.1% had a PD hospital admission within a year of giving birth. The percentage decreased slightly to 1.8% for T2 mothers. Amongst the diagnostic categories of PD, adjustment disorders had the highest occurrence for both T1 and T2 mothers. Note that adding up the frequencies of the various diagnostic categories slightly exceeds the frequency for any PD admissions because some mothers had separate admissions to hospital under different principal diagnostic codes.

Using kernel density estimation, Fig. 1a presents descriptive data and graphs the raw distribution of PD hospital admissions (i.e. not controlling for any covariates) for T1

Table 2 PD hospital admissions within 1 year after giving birth—frequency total and by diagnosis

Admission type	Frequency	Percent of cohort
Child born January–June 2009 (*N* = 25,361) T1		
Any PD	535	2.11
Schizophrenia	13	0.05
Unipolar	58	0.23
Bipolar	13	0.05
Adjustment	277	1.09
Puerperal psychosis	110	0.43
Other	105	0.41
Child born July–December 2009 (*N* = 25,466) T2		
Any PD	458	1.80
Schizophrenia	10	0.04
Unipolar	47	0.18
Bipolar	5	0.02
Adjustment	269	1.06
Puerperal psychosis	64	0.25
Other	81	0.32

PD psychiatric disorders

mothers relative to control group mothers giving birth between 1st Jan and 30th June of 2007 and 2008, conditional on having a PD hospital admission during the 2-year window around the date of giving birth. In our context, the density or probability depicted on the vertical axis in Fig. 1a describes the relative likelihood that PD hospital admissions occur on a particular day relative to the birth date of the child. The first weeks and months after delivery (in particular the first 60 days) are associated with an increased risk of PD hospital admissions. While the pre-birth admission trends for the three groups are rather similar, there is a noticeable reduction in the frequency of PD admissions for T1 mothers within half a year after giving birth.

The raw distribution of PD hospital admissions for T2 mothers relative to control group mothers giving birth between 1st July and 31th December of 2007 and 2008 is shown in Fig. 1b. For T2 mothers, the trend in hospital admissions before and after birth is considerably different to the control groups and to T1 mothers. Approximately 300 days prior to giving birth (e.g. mothers giving birth in October 2009 would have been exposed to NPDI for about 300 days), we observe a considerable increase in PD hospital admissions.

We now turn to estimating average treatment effects of the NPDI using propensity score methods. Figure 2 provides a comparison of the estimated propensity scores that are used in the weighted regression models for each of the relevant pairwise comparisons (see panels a–d). The propensity scores reflect the probability that each observation is part of the treatment (i.e. NPDI exposure) group and is a diagnostic tool to measure treatment and control group comparability. In all cases, there is substantial overlap in the estimated propensity scores using a probit model, suggesting that the distribution of the covariates are balanced in expectation across the two groups. Propensity score matching helps to eliminate any remaining differences in characteristics between the treatment and comparison groups that were present in Table 1.

The estimates of the impacts of the NPDI that are based on the matched samples are provided in Table 3. The table focusses on presenting multivariate results for postnatal PD admissions and postnatal admissions for adjustment/stress disorders—the PD category with the highest incidence. The outcomes for the matched sample are regression adjusted using a probit model as the outcomes are binary variables. Overall, it appears that the NPDI had a small significant impact on reducing any postnatal PD hospital admissions for T1 mothers (top panel), and a relatively larger significant impact for T2 mothers (bottom panel). The results also suggest that adjustment disorders are the main drivers of the results observed, with the patterns of the signs and size of the coefficients largely mirroring the results for any PD admissions.

As our primary analyses involved multiple post-birth periods, as a robustness check, the finding might also be interpreted in the light of multiple hypothesis testing. For example, a Bonferroni correction could be performed so that each individual hypothesis for a particular treatment/control comparison given in a single row in Table 3 are tested at a significance level of α/m, where α is the chosen significance level and m is the number of hypotheses tested. Under this more conservative perspective, we still find statistically significant impacts of the NPDI on adjustment disorders within 360 days for the pairing of T2 mothers relative to control group mothers giving birth between 1st July and 31th December of 2007 or 2008.

Discussion

Principal Findings

Using historical matched control groups, we find statistically significant reductions in PD admissions in NSW and WA in the first postnatal year after the introduction of the NPDI. These are mostly attributable to a reduction in adjustment disorders.

There are considerable economic implications for these findings. While the estimated impacts in Table 3 appears to be small in magnitude, they are economically significant. For example, consider the result for T2 mothers (any PD admission within 360 days of birth) that has a coefficient

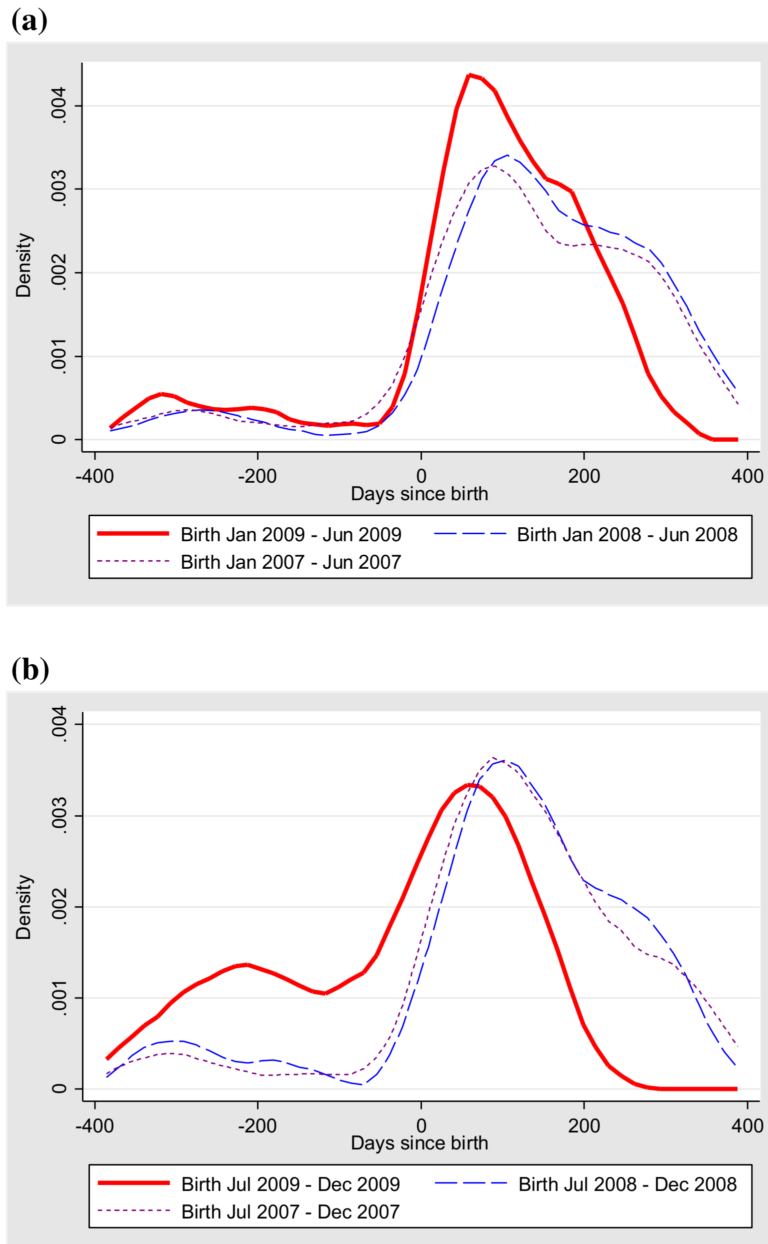
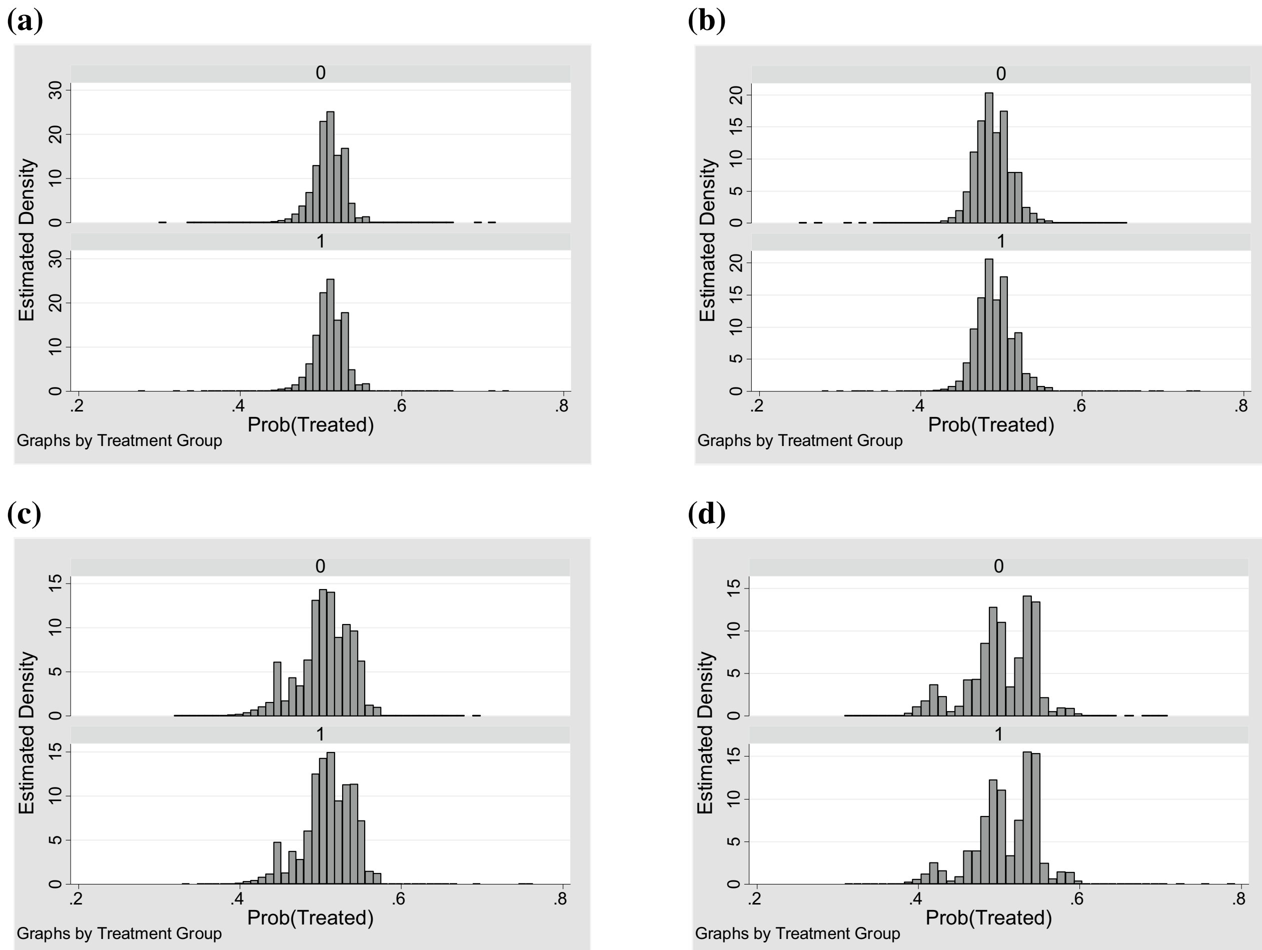


Fig. 1 Kernel densities of any PD hospital admission across the perinatal period (conditional on PD admissions in the 2-year window around the date of birth). **a** Comparing NPDI January–June 2009 birth cohort (T1) with other recent birth cohorts. *PD* psychiatric Disorders, *NPDI* National Perinatal Depression Initiative. **b** Comparing NPDI July–December 2009 birth cohort (T2) with other recent birth cohorts. *PD* psychiatric disorders, *NPDI* National Perinatal Depression Initiative

of −0.009. This 0.9% point reduction is based on a mean of 1.8%, which therefore translates to a 50% reduction in PD admissions. This implies a large reduction in hospital resources for PD in a single year, implying more hospital resources that can be channelled towards treating other conditions.

Based on our findings, we hypothesise that the decrease in PD postnatal admissions is due to increased routine screening and patient and carer awareness under the NPDI that led to earlier detection and treatment (including hospital admission for more severe cases) of PD. While not conclusive, some supporting evidence of this hypothesis is provided in the data on PD admissions. PD admissions depicted in Fig. 1, which are conditional on having a PD hospital admission during the 2-year window around the date of giving birth, suggest that mothers who would have had a PD admission in the perinatal period are more likely to have any PD (new onset or relapse) detected early under the NPDI. Immediately after the introduction of the NPDI (January–June 2009), it appears that there was a much higher detection of PD which resulted in an increased frequency of hospital admissions for PD in the first 60 days following birth (see Fig. 1a). Consistent with the notion that awareness of the NPDI is expected to increase over time, we observe mothers giving birth in the latter half of



T: Treatment group; C: Comparison group; Prob: probability.

Fig. 2 Overlap in propensity scores. **a** T = Born Jan–Jun 2009; C = Born Jan–Jun 2008, **b** T = Born Jan–Jun 2009; C = Born Jan–Jun 2007. **c** T = Born July–Dec 2009; C = Born July–Dec 2008, **d** T = Born July–Dec 2009; C = Born July–Dec 2007. *T* treatment group, *C* comparison group, *Prob* probability

2009 and in a stronger NPDI environment more likely to receive earlier detection and treatment (see Fig. 1b).

Returning to the question posed in the introduction of this paper, it appears that the NPDI on the whole has increased PD admissions prior to giving birth (due to earlier detection) and decreased PD admissions after birth. While it is possible that this reduction in postnatal admissions was a result of the NPDI—for example by way of increased monitoring of existing PD leading to early (pregnancy) episode detection and treatment (including admission as required)—replication of our findings with additional data beyond 2010, would strengthen these results and support future policy recommendations (see "Conclusions").

This is aligned with earlier research that found changes in uptake of Medicare mental health items across the perinatal period pre and post the NPDI (Chambers et al. 2016). Both the earlier Medicare policy analysis (of primary sector mental health consultations) and this policy analysis (of PD admissions) suggest that the NPDI has systematically shifted care to being earlier in the perinatal period and more to the primary care sector.

Given the importance of developing a strong bond between mother and child, this shift in PD admissions to a period prior to the birth of the child has important flow-on implications for the wellbeing of the child. Mothers will now potentially get their PD treated early, allowing them to focus on the task of providing the sensitive maternal care in the postnatal period that is associated with secure attachment formation in infants. This is especially relevant for women with pre-existing PD who often drop out of treatment in pregnancy and those whose PD arises in pregnancy (Cohen et al. 2006; Viguera et al. 2007; Wisner et al. 2013). Such secure attachment is critical to healthy offspring development—both emotional and behavioural (Howard et al. 2014).

Table 3 Impacts on hospital admissions within 1 year after giving birth

Comparison group	(1) Within 30 days	(2) Within 60 days	(4) Within 120 days	(6) Within 180 days	(7) Within 360 days
Treatment group T1 (children born Jan–June 2009)					
Outcome: Any PD hospital admission relative to time of birth					
Jan–Jun 2008 (N = 49,749)	0.001** (1.95)	0.001*** (2.65)	0.001 (0.69)	0.000 (0.25)	−0.003** (2.55)
Jan–Jun 2007 (N = 51,657)	0.000 (0.07)	0.000 (0.45)	−0.001 (0.91)	−0.001 (1.13)	−0.003** (2.35)
Outcome: Any adjustment disorder (F43) hospital admission relative to time of birth					
Jan–Jun 2008 (N = 49,749)	−0.000 (0.53)	0.000 (0.49)	−0.001* (1.80)	−0.002 (1.31)	−0.003*** (2.84)
Jan–Jun 2007 (N = 51,657)	0.000 (0.30)	0.000 (0.21)	−0.001 (1.44)	−0.002** (2.02)	−0.003*** (3.28)
Treatment group T2 (children born July–December 2009)					
Outcome: Any PD hospital admission relative to time of birth					
July–Dec 2008 (N = 50,215)	−0.001*** (2.91)	−0.002*** (3.81)	−0.004*** (4.19)	−0.005*** (5.03)	−0.009*** (7.31)
July–Dec 2007 (N = 50,291)	−0.001** (2.08)	−0.002*** (3.19)	−0.003*** (3.41)	−0.005*** (4.89)	−0.008*** (6.29)
Outcome: Any adjustment disorder (F43) hospital admission relative to time of birth					
July–Dec 2008 (N = 50,215)	−0.0003** (2.40)	−0.001*** (2.99)	−0.002*** (2.64)	−0.003*** (3.21)	−0.004*** (4.24)
July–Dec 2007 (N = 50,291)	−0.000*** (2.62)	−0.001*** (3.30)	−0.002*** (3.38)	−0.004*** (4.78)	−0.006*** (5.51)

Absolute values of Z-statistics in parentheses

Each cell represents results from a different regression. Only the coefficient on the treatment group variable is reported. Covariates included in the model are: mother's age and age squared, marital status, insurance status, jurisdiction, socio-economic index, and PD hospital admissions history

PD psychiatric disorders

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Strengths and Limitations

A key strength of the current study is the use of population level data of births and PD hospital admissions across two jurisdictions to assess the impact of the NPDI. Women with a history of persisting PD before pregnancy are an identifiable high-risk group. Data on the history of any prior PD hospital admissions prior to giving birth (which is included as a covariate in the model) is important in helping us with identification of the statistical approach employed. The chosen statistical approach for estimating causal effects that is based on inverse probability weighting also works best when sample sizes are large, as inverse probably weighting can be very sensitive to observations with large weights (Hirano and Imbens 2001).

However, there are also several limitations of the analysis. First, as with any quasi-experimental approach based on retrospective data, the estimated impacts are only unbiased when there is no unobserved confounding. It is possible that there remain unobserved factors not accounted for (e.g. changes in hospital psychiatric admissions across the 2-year period). Ideally, randomised trials would be conducted while implementing the reforms. If this were to be done in other countries, it would help validate the findings in this study. Second, the follow-up period to the NPDI reforms is limited to one year in the current study. Our evaluation of the NPDI is therefore limited to the elements of the program that were introduced in 2009. With data allowing an analysis of mothers giving birth in 2010 or later and more observed data on inpatient hospitalisations beyond 2010, it will be possible to ascertain if there are potentially larger impacts of the NPDI once the full dimensions of the reform can be taken into account.

The impact of additional counselling services such as the Access to Allied Psychological Services program which begun early 2009, could not be captured in our study which evaluated hospital admissions not community based services. Any future evaluation of the impact of the NPDI on hospital admissions would need to try and account for this as a possible confounder.

Conclusions

The perinatal period is associated with an increased risk of severe PD for mothers which can have long-term implications for the wellbeing of the woman, the baby, her family, and wider society. The NPDI that was funded and implemented in all states in Australia between 2009 and 2015 was a large-scale public health intervention that attempted to identify mothers with PD and treat the illness in the early stages. To date, there has been no evaluation of the NPDI in terms of whether it met its program objectives. Our findings that the NPDI is associated with fewer post-birth PD hospital admissions suggests that early screening of women at risk during their perinatal period can have beneficial effects.

Due to fiscal concerns, in 2013, the Australian Federal Government did not extend their funding agreement with the states and territories to provide care for women with perinatal depression, although the commonwealth and states continued to fund the program for two more years. Future work would seek to strengthen these findings by analyzing the hospital admission data available for the period 2011–2015 as well as exploring the cost effectiveness of routine depression screening in the perinatal period and the economic costs of mothers, families and the Australian taxpaying community.

In conclusion, our results suggest that reduced postpartum admission frequency may be associated with the NPDI. Early assessment, detection and treatment in the perinatal period and subsequent reductions in post-birth PD admissions can help increase the quantity and quality of time spent by mothers with their babies. This would facilitate uninterrupted breastfeeding that gives babies the best start for a healthy life, and increase the bond between mother and child. Such reductions in PD admissions will also help ease demand pressures on the scarce supply of psychiatric hospital beds in Australia. Therefore, our findings suggest that the decision made to discontinue funding this important initiative should be reevaluated.

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Author Contributions WSL proposed the statistical study design, conducted the analyses and wrote the draft of the paper. CM, MLC, GC, NH, VM, ES and MPA were all involved in the developing the study aims, developing and accessing the main linked dataset and revised the article for content and interpretation. CM and MPA also provided overall study leadership in terms of developing the study context. MLC provided extra assistance with data preparation. All authors have read and approved the final version submitted.

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Data Availability The data that support the findings of this study are available from the Western Australia Data Linkage Branch, Department of Health (WADLB) and the New South Wales Centre for Health Record Linkage (CHeReL) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of WADLB and CHeReL.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of retrospective study formal consent is not required. The study was approved by the Government of Western Australia Department of Health Ethics Committee (ref:2012/36), NSW Population & Health Services Research Ethics Committee (ref: 2012/04/386), University of NSW (ref: HC12518) and Deakin University (ref: 2012/290) Human Research Ethics Committees.

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