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Maternal postnatal depression and completion of infant immunisations: a UK cohort study of 196,329 mother-infant pairs, 2006-2015

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Abstract

Objective: To examine the relationship between maternal postnatal depression and completion of infant vaccinations.

Methods: We conducted a cohort study using data from The Health Improvement Network (THIN), a large UK primary care electronic health record database. We identified 196,329 mother-infant pairs where the infant was born between 2006-2015. Postnatal depression was identified through antidepressant prescriptions, diagnoses or symptoms of depression in first year after childbirth. Primary outcome was completion of three 5-in-1 vaccination doses in infants before one year of age. This vaccine protects against Diphtheria, Tetanus, Whooping Cough, Polio and *Haemophilus influenzae* type b. We used Poisson regression models to compare likelihood of infant 5-in-1 vaccine uptake among children of women with a record of postnatal depression to those without.

Results: Of the 196,329 women, 20,802 (10.6%) had a record of postnatal depression and/or antidepressant prescription. There was no difference in infant's 5-in-1 vaccination completion between mothers with a record and those without (adjusted IRR: 1.01, 95% CI: 0.99-1.02). Those from more socially deprived areas were less likely to complete infant vaccinations compared to those from the least deprived areas (IRR: 0.92, 95% CI: 0.90-0.93). Likelihood of completing infant vaccination decreased over time, comparing 2014-2015 to 2006-07 (IRR: 0.90, 95% CI: 0.89-0.92).

Conclusions: Among mothers who engage with primary care, maternal postnatal depression is not associated with lower rates of infant vaccination; though we cannot conclude that more severe depression or unrecognised depression is associated with lower completion rates.

Keywords: Maternal Health, Electronic Health Records, Depression, Child health

Introduction

Postnatal depression affects up to one in five mothers[1–4] and can have a devastating impact on both mothers and infants.[5–7] There is some evidence that depression in mothers could affect the quality of care and support they give their infant and there is increasing evidence that it can alter the level of healthcare infants receive,[8,9] although the causal mechanism is not well understood. Previous studies have shown that infants of women with postnatal depression are higher users of urgent/unplanned care;[8] but it is not clear if these infants have more complex health needs which could impact on the mental health of the mother or vice-versa. Adding to this, studies have shown that the infants of mothers with depression may be less likely to attend preventative or planned healthcare measures.[9–11] A small number of studies have explicitly examined adherence to infant immunisation schedules in mothers with postnatal depression; however, no studies have been conducted in the United Kingdom (UK).[9–14] The results from these studies are mixed and the link between postnatal depression and infant vaccine uptake remains inconclusive. Previous studies have been limited by small sample sizes or being restricted to specific sub-populations, making it difficult to draw broader conclusions, our study will draw on a large general population in the UK.

In the UK, the 5-in-1 vaccine was introduced in 2006 and was replaced by the 6-in-1 vaccine in 2017.[15] All infants should receive three doses of the vaccination at 2, 3 and 4 months of age.[15] This combined vaccination protects against Diphtheria, Tetanus, Pertussis (Whooping cough), Polio and Hib Disease (*Haemophilus influenzae* type b);[15] non-adherence to this immunisation schedule puts an infant at risk of developing these life-threatening diseases. [16]-[17] This vaccination is one of the first preventative health measures an infant receives and is an essential part of the UK vaccination programme.

UK rates of vaccinations are broadly comparable to other similar countries and in-line with the World Health Organisation (WHO) target of 95.0%.[18] In 2015, the Organisation for Economic Co-operation and Development (OECD) data on the percentage of children who received their

Diphtheria, tetanus, pertussis vaccination at 1 year of age (the most comparable indicator available) identified that in the UK, 95.0% of children were vaccinated compared with 95.0% in the United States (US), 93.0% in Germany and 97.0% in France.[19] While national coverage is generally high, there is substantial regional variation. In particular, London consistently reports lower vaccination coverage than other regions. In 2015-16, only 89.2% of infants in London had received their 5-in-1 vaccination at 1 year of age.[16] Barriers to vaccine uptake may include capability, health beliefs and opportunities.[20] For example, uptake is lowest among infants of teenage/younger mothers, those living in poorer areas and some ethnic groups who are susceptible to misinformation or fear or mistrust of vaccination programmes. [21,22]

In the UK, electronic health records from primary care provides a detailed picture of the care both mothers and infants receive. Thus, primary care is the first source of support for most women experiencing postnatal depression. Likewise, it is the typical setting for infant vaccinations. In this study, using linked mother and infant primary care records, we aim to determine if infants were less likely to receive their 5-in-1 vaccination if their mother had sought support for postnatal depression.

Methods

UK healthcare

In the UK, healthcare is free at the point of delivery for all residents as part of the National Health Service (NHS). Primary care is typically the first point of contact and is largely delivered by General Practitioners (GPs) and other health care professionals (nurses and health visitors) within a practice. Information about patients and their health are collected during primary care consultations and recorded on the practice computer system. This information is primarily used for clinical care but is also widely used for research through large, anonymised healthcare databases such as The Health Improvement Network.

Most women in the UK give birth in a hospital setting and are discharged home 1-2 days after childbirth, although this may be longer for those who have a caesarean or complex delivery. For the first few days and weeks after childbirth, women and new-borns have access to midwives & health visitors through community services. They are responsible for supporting with feeding, safe-sleeping advice, new-born checks, women's initial recovery from childbirth and how everyone is adjusting to a new baby.[23] This care typically involves home visits and telephone support. Some women are seen more often and for longer depending on their needs. They are then discharged to their GP and responsibility for their care returns to primary care.

When babies are 6 to 8 weeks old, both mother and infant are invited for separate check-ups with their GP, although they are usually scheduled together in the same visit. The purpose of the infant check is to conduct a thorough physical examination. In addition, infants will begin their routine vaccination schedule (see: 'Infant 5-in1 vaccination adherence' below). In the UK, infants do not see a paediatrician unless they require specialist care, but will have two further routine reviews at 9-12 months and 2-2 and a half years old. The purpose of the mother's 6-8 week check is to evaluate their mental and physical health, and assess how women are recovering after pregnancy

and birth. As they would at any other time, women and infants can use hospital care in an emergency or for planned care where they are referred through their GP."

Data source

We used data from the Health Improvement Network (THIN) database between 1 January 2006 and 31 December 2016. This database contains the electronic medical records of more than 12 million patients across the UK from over 700 general practices.[24] THIN contains patient-level information on characteristics (such as sex, age and social deprivation), symptoms, diagnoses, medications, and preventative healthcare measures – including vaccinations. Each individual can be linked to members of their household by a unique family number. Symptoms, diagnoses and healthcare information are entered by GPs and nurses using Read codes, a hierarchical medical coding system.[25] Additional Health Data (AHD) records contain information on preventative care, including immunisations and vaccinations. A number of studies have confirmed patients in THIN are representative of the UK population in terms of sex, age, ethnic group and medical conditions.[26,27] However, practices that contribute data to THIN tend to be from more affluent areas and as such, there may be an under-representation of women from the most deprived areas. In THIN, the Townsend index provides an area based measure of deprivation based on: postcode, unemployment, car ownership, home ownership and household overcrowding.[28] The Townsend index is used to create 5 groups using quintiles, 1 being least deprived and 5 being most deprived.

We excluded practices that did not meet our data quality criteria of acceptable computer use (ACU) or acceptable mortality rates (AMR) by the infant's date of birth. ACU is the date a practice was continuously entering on average at least two therapy records, one medical record and one additional health data record per patient per year;[29] and AMR is the date a practice has comparable mortality rates to the rest of the UK, given the size and demographics of the practice.[30] We only included women who had been registered at a practice for at least six months to ensure their

current practice had their full medical information. A small proportion of individuals were also missing information on Townsend scores and were excluded from the study.

Study population

Mother-infant cohort

Potential mother-infant pairs were identified by a recorded childbirth in a women's electronic health record and an infant first registered within the same household at the time of birth. In a mother's record, childbirths and date of childbirth were determined using a combination of an antenatal record, delivery record, postnatal care record or date of last menstrual period. If women had multiple infants in the study, one was selected at random for inclusion.

To coincide with the 5-in1 vaccine, we included women of childbearing potential (aged 15 to 49 years) who gave birth between 1st January 2006 and 31st December 2015. This allowed for a final year of follow-up for those born in 2015. Infants or mothers with less than one year of follow-up information (if they had died or transferred practice in this time) were excluded.

Definition of variables

Maternal postnatal depression

From the date of childbirth, women were followed-up for 12 months to identify a record of postnatal depression. Previously, it was anticipated women would recover from pregnancy within the first six to eight weeks after childbirth (the puerperium) and much of the research and clinical care had focused on this time window. However, there is increasing evidence that women have ongoing health needs throughout the first year after childbirth and so we have extended our period of follow-up period to include the first year after childbirth. Mothers were defined as having sought support for postnatal depression if their records contained at least one of either: a symptom of depression (such as 'low mood'), a diagnosis of depression (such as a record of 'postnatal depression') or an antidepressant prescription.[31] Read codes were used to identify a symptom or diagnosis and British National Formulary (BNF) codes to identify antidepressant prescriptions issued. A full list of the Read codes used is included in an Appendix. A small number of women may

be prescribed antidepressants for reasons other than depression; however, only relying on recorded symptoms and diagnoses is likely to underestimate the number of women with depression after giving birth. There may be a delay in women reporting symptoms and seeking treatment for depression. Hence, a large proportion of women have a first record of depression at their planned postnatal check[31] which typically takes place 6-8 weeks after birth. As there is some variation in the time these checks take place, women may have their postnatal depression identified on the same day as their infant's first vaccination dose or later, even though symptoms started earlier. Therefore, we took any record of depression in the 12 months after childbirth to be those with the exposure, not just those which were recorded before first vaccine dose.

Infant 5-in1 vaccination adherence

Infants should receive three doses of the 5-in-1 vaccination, typically scheduled at weeks 8, 12 and 16 after birth. To allow for some flexibility in the timing of these doses, national coverage to receive all three doses is measured at 12 months after birth.[32] Thus, our primary outcome was three doses of the 5-in1 vaccine in infants between date of birth and up to one year after birth. The 5-in-1 vaccine was identified through an infant's Additional Health Data record. Multiple vaccination records on the same day were grouped and considered to be one dose. The stage or dose of the vaccination (1-3) was also extracted. As contraindications to the 5-in-1 vaccine are extremely rare we considered all infants as being eligible for this vaccination.

Maternal characteristics

We stratified our analysis by maternal age (years), Townsend score and calendar year. Maternal age was grouped into five-year bands. Calendar year was grouped into two-year bands.

Statistical analysis

A table was derived to show characteristics of women at time of childbirth, comparing those with and without postnatal depression. For the primary outcome measure, the proportion of infants who completed all three doses of the 5-in1 vaccination is given, comparing those with and without postnatal depression, stratified by characteristic. Random effect Poisson regression models were

constructed to compare the likelihood of infant 5-in-1 vaccine uptake in women with postnatal depression to women with no recorded postnatal depression. Three models were developed: unadjusted, age-adjusted and age-deprivation adjusted. To account for clustering with GP, GP practice was included as a random effects term, and the log of follow-up time was included as an offset. All analyses were conducted using Stata V.16 (StataCorp, College Station, Texas, USA).

Ethical approval and data access

Approval was received from the Scientific Review Committee on 17/06/2019 (THIN protocol number: 19THIN053). THIN is a registered trademark of Cegedim SA in the UK and other countries. Reference made to THIN database is intended to be descriptive of the data asset licensed by IQVIA. This work uses de-identified data provided by patients as a part of their routine primary care.

Results

Participants

We identified 196,329 mother-infant pairs where the infant was born between 1 January 2006 and 31 December 2015 (Figure 1).

Maternal characteristics

Of the women included in this study, 10.6% (n=20,802) had a record of postnatal depression. Around half of these women (48.6%, n=10,112) were identified by a symptom or diagnostic Read code of depression; 32.7% (n=6,810) were identified as having an antidepressant prescription; and the rest (18.7%, n=3,880) had records of both (data not shown). A higher proportion of women in teenage groups had postnatal depression (16.8% of those aged 15-19 years vs 9.0% of those aged 30-34 years) and those from more deprived areas were more likely to have depression (14.9% in most deprived group compared to 9.4% in least deprived group). Groups were broadly similar across calendar time (Table 1).

Infant 5-in1 vaccination adherence

The overall vaccination rate in this study was high (94.5%); and was similar in those with and without a record of postnatal depression (95.1% vs 94.4%) (Table 1). After adjusting for age and social deprivation, we found no difference in vaccination rates between the two groups (adjusted IRR: 1.01, 95% CI: 0.99-1.02) (Table 2) or in time to complete all vaccination doses (Figure 2). Likelihood of completing infant 5-in-1 vaccination increased with age, comparing those aged 30-34 years to those aged 15-19 years (adjusted IRR: 0.97, 95% CI: 0.95-1.00). Those from more socially deprived areas were less likely to complete infant vaccinations compared to those from the least deprived areas (IRR: 0.92, 95% CI: 0.90-0.93). Likelihood of completing infant 5-in-1 vaccination decreased over time, comparing 2014-2015 to 2006-07 (IRR: 0.90, 95% CI: 0.89-0.92) (Table 2).

Discussion

Main findings

The vast majority of infants in our study (94.5%) completed their 5-in-1 vaccination by 1 year of age. We found no difference in uptake when comparing mothers with and without a record of postnatal depression (adjusted IRR: 1.01, 95% CI: 0.99-1.02). Those from the most socially deprived areas were 8% (7-10%) less likely to complete their infant vaccination relative to those from the least deprived areas. The likelihood of completing infant 5-in-1 vaccination decreased over time, infants in 2014-2015 were 10% (8-11%) less likely to complete their vaccination relative to those in 2006-07.

Study strengths and limitations

This is one of the largest (196,329 mother-infant pairs) representative, population-based studies to date to examine the impact of maternal postnatal depression on infant vaccination, and the first in a UK setting. The use of primary care electronic health records provides a reflection of real-world clinical practice which limits the impact of recall and selection bias. Our study may be limited by our interpretation of the temporal relationship between postnatal depression and vaccine uptake. We considered those with any record of depression in the 12 months after childbirth to be in the exposed group, not just those where depression was recorded before first vaccine dose. We recognise that having a record of depression towards the end of the first year after birth may not always be reflective of woman's health in the early postnatal period prior to first vaccine dose. However, as the majority of women with postnatal depression are identified in the first 8 weeks after childbirth[31] we anticipate this would only impact on a small number of women in our study and is unlikely to change our findings. Some women may have depression but do not seek support from their GP. It is possible that women who do not engage with postnatal primary care because they are depressed would also be less likely to have their infant vaccinated; however, it is not possible to identify these women in our study. Lastly, our cohort has an overrepresentation of women from more affluent areas. Thus, our overall estimates of vaccine uptake may be slightly over-estimated.

Findings in relation to previous studies

A small number of studies have explored the relationship between maternal postnatal depression and infant vaccination uptake and found mixed results. Two small studies (n<200) found a relationship, with infants of mothers with postnatal depression being less likely to be vaccinated;[9,12] These studies were, however, based on specific study populations. Thus, Zajicek-Farber et al examined non-white women with high-risk pregnancies[9] and Turner et al included only participants from older age groups.[12] On the other hand, one slightly larger study (n=4,874) found no difference in infants receiving three doses of diphtheria, tetanus and pertussis (DTP) by 7 months of age (adjusted OR: 0.85, 95% CI 0.71-1.01).[11]

From two larger studies (>10,000), using population datasets, one study found no difference and the other found that vaccine uptake was lower in mothers with depression.[10,13] Similar to our findings, a 2013 American study of 24,263 infants born between 1998 and 2007 found no difference in infant vaccination uptake in relation to a mother's perinatal depression status[13] (authors did not distinguish between depression in pregnancy or postpartum). In mothers with depression compared to no depression, the likelihood of infants receiving all recommended immunisations was the same (adjusted IRR: 1.0, 95% CI 1.0–1.0). Rates of perinatal depression in this study (13.4%) are roughly comparable with our estimates (10.6%). In contrast, a 2018 Danish study investigating healthcare use in 853,315 women between 2000 and 2013 found a significant difference in infant vaccination uptake in mothers with depression. Those with previous depression were 3% (95% CI 1-5%) less likely to attend diphtheria/tetanus/pertussis/polio (DiTe) infant vaccination appointments compared to those with no record of depression and those with recent depression were 7% (95% CI 4-10%) less likely to attend.[10] The difference between these findings and ours may be due to the narrow definition of postnatal depression used in the Danish study. As authors note, the Danish database contains information on hospital care only and identifying depression required multiple antidepressant prescriptions or hospital visits. These specific criteria resulted in a relatively low

overall rate of maternal depression in their study (estimates of 'recent' depression across the first year after childbirth ranged from 1.4% to 2.7%). This suggests the study identified a difference in infant vaccination uptake in women with more severe depression. In contrast, we used a broader definition of depression, which included prescribing, symptomatic and diagnostic information within a primary care setting. This resulted in identifying a larger proportion of women with postnatal depression (10.6%).

The rate of postnatal depression we identified (~10%) is similar to other studies which have used electronic health records[31] but will inevitably underestimate depression that is not identified or recorded during primary care consultations. Other studies that specifically screen for depression typically identify higher proportions. Therefore, we are limited by the information contained within electronic health records but have used as broad a definition as possible by examining any indication of depression in the year after birth. Our overall infant vaccination rate (94.5%) is also similar to UK National coverage statistics (93.6%).[16]

Implications of findings

It is reassuring that infant vaccination uptake in mothers with a record of postnatal depression is similar to children of mothers without. There remains much stigma in experiencing a mental health condition after childbirth and our findings suggest that the majority of women continue to access essential early preventative care for their children, despite experiencing potential difficulties with their own health. These positive findings may indicate that health systems which routinely screen for postnatal depression are protective of women who have it. In particular in the UK, women are invited to a postnatal check with their GP six weeks after birth which is an essential point of screening for postnatal depression.[31] This planned check is not routinely offered in all countries and this may in part explain that despite having depression in the UK, women have good access to essential primary care services and prevention for themselves and their infants.

Infant vaccinations are an important opportunity not only to provide infant care but also to review the health of the mother, as many infants attend their vaccinations it may be possible to identify concerns relating to a mother's mental health which could be followed up in subsequent appointments. Non-attendance or a delay in immunisation can be very serious for infant health but could also indicate a mother needs additional care or follow-up. It is important to understand and address reasons for missed vaccinations, and in particular why rates have decreased over time and are lower among more deprived groups; further research could also examine regional variation identified by other studies. There are many reasons an infant may not be vaccinated and mothers with undiagnosed or untreated depression may be a factor. Further research should examine if vaccination adherence is similar in those with depression who did not seek support and if adherence is different in mothers with more severe depression, which may be indicated in a previous study.[10]

Conclusion

Our findings add further evidence that among new mothers who engage with primary care, symptoms of or receiving treatment for maternal postnatal depression is not associated with lower rates of infant vaccination in a large UK mother-infant cohort, though further research may be needed to examine if unrecognised depression is associated with lower adherence.

Conflicts of interest:

Ms Smith, Professor Saxena and Professor Petersen have no conflicts of interest to disclose for this study.

Clinical Points:

- Previous studies investigating the link between postnatal depression and infant vaccine uptake have found mixed results.
- Postnatal depression is not associated with lower rates of infant vaccination in a large UK mother-infant cohort.

Data availability:

No additional data are available as this work draws on de-identified data provided by patients as a part of their routine primary care. THIN data are available upon application after Scientific Review Committee (SRC) approval through a licenced organisation. More information is available at: https://www.the-health-improvement-network.com/

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