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Incidence, antibiotic treatment and outcomes of lactational mastitis: Findings from The Norwegian Mother, Father and Child Cohort Study (MoBa)

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Abstract

Background: Mastitis is a common and distressing maternal postpartum condition, but the relationship between mastitis timing and antibiotic treatment and breastfeeding outcomes and postnatal mental health is unclear.

Objectives: To describe the incidence of mastitis and treatment with antibiotics in first 6 months postpartum, and to investigate the impact of mastitis timing and antibiotic treatment on breastfeeding practices and postnatal mental health.

Methods: This study is based on 79,985 mother-infant dyads in the Norwegian Mother, Father and Child Cohort Study (MoBa). Women were classified according to self-reported mastitis within first month ('early') or 1–6 months ('later') postpartum and antibiotic treatment. Breastfeeding outcomes included *predominant* or *any* breastfeeding and abrupt breastfeeding cessation until 6 months postpartum. Maternal mental health was assessed by self-report at 6 months postpartum.

Results: The incidence of mastitis was 18.8%, with 36.8% reporting treatment with antibiotics. Women reporting early mastitis were less likely to report *predominant* breastfeeding (adjustedd relative risk [aRR] 0.92, 95% confidence interval [CI] 0.86, 0.99) and *any* breastfeeding for 6 months (aRR 0.97, 95% CI 0.96, 0.98) than women who did not report mastitis, and more likely to report abrupt breastfeeding cessation (aRR 1.37, 95% CI 1.23, 1.53). Late-onset mastitis was not associated with poorer breastfeeding outcomes. Among women reporting mastitis, the risk of abrupt breastfeeding cessation was higher in those also reporting antibiotic use. Mastitis was

associated with an increased risk of mental health problems postpartum which was highest among those reporting no antibiotic use (aRR 1.29, 95% CI 1.18, 1.41), in contrast to those also reporting antibiotic use (aRR 1.08, 95% CI 0.96, 1.22).

Conclusions: Lactational mastitis and its associated treatment with antibiotics are common. Early (<1 month postpartum) mastitis appears to be a modest risk factor for suboptimal breastfeeding outcomes. In addition, mastitis is associated with poorer mental health.

KEYWORDS
antibiotics, breastfeeding, lactation, mastitis, maternal health, Norway

1 | BACKGROUND

Lactational mastitis is a debilitating inflammatory breast disease associated with significant maternal morbidity.[1,2] Mastitis is characterised by localised breast pain, tenderness, erythema and engorgement, and systemic symptoms such as fever, accompanied by malaise and rigours.[3] The percentage of women experiencing mastitis during breastfeeding varies widely depending on study sample, setting and length of follow-up, with reports ranging from 2.5% to 20%.[4] Most cases occur in the first four weeks postpartum and may recur in months two and three, and disrupt activities of daily living.[4,5]

The aetiology of mastitis remains unclear and may be due to inflammatory, infectious or multifactorial causes.[6] In infective mastitis, *Staphylococcus aureus* is the most common pathogen,[7] and if symptoms do not resolve with self-management strategies, or are moderate or severe, treatment with antibiotics may be required.[3] Additional treatments for mastitis include the use of analgesics and anti-inflammatories to treat associate pain and/or fevers.[3] Further, in Norway, oxytocin nasal spray is utilised to facilitate milk ejection.[8]

The relationship between mastitis and breastfeeding duration is less clear. Some studies showed that mastitis or other postpartum infections are associated with premature cessation of breastfeeding,[9,10] or lower exclusive breastfeeding rate,[11] while others found no association between mastitis and shorter duration of breastfeeding[12] or that mastitis was associated with longer duration of breastfeeding.[13] Further, while some studies have reported on the prevalence of antibiotic use for treating mastitis,[14] no studies have investigated differences in breastfeeding outcomes following antibiotic use for mastitis.[15–17] Breastfeeding is well supported in Norway with 98% initiation, 85% of hospitals accredited as Baby Friendly.[18,19]

Previous studies have found an association between mastitis and breastfeeding pain and profound negative effects on women's mental health status,[20–22] but less well explored are the effects of treatment of mastitis on these associated symptoms.[23] Currently, postpartum physical and mental health are often considered separately in research and clinical practice. Postpartum women commonly receive postpartum care in 'silos'—for example, medical, lactation and psychological care.[22]

Therefore, the objective of this paper was twofold. First, we aimed to describe the incidence of mastitis and associated treatment with antibiotics in the first 6 months postpartum. Second, we aimed to investigate the impact of timing of mastitis and treatment with antibiotics on breastfeeding practices and maternal mental health postpartum.

Synopsis

Study question

Are timing and antibiotic treatment of mastitis associated with breastfeeding duration and maternal mental health?

What's already known

Mastitis is a common and distressing problem for postpartum women. Although some studies have reported that mastitis is associated with shorter duration of breastfeeding, others have found no association. It is possible that timing and antibiotic treatment influences whether women cease breastfeeding prematurely.

What this study adds

Using a very large population-based data set, we demonstrate that early (<1 month), but not later (1–6 months) mastitis is a modest risk factor for suboptimal breastfeeding outcomes. Antibiotic treatment may be associated with differences in breastfeeding outcomes. Irrespective of timing, mastitis is associated with poorer mental health.

2 | METHODS

2.1 | Study design and data source

This study is based on data from the Norwegian Mother, Father and Child Cohort Study (MoBa), a prospective population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health.[24] Participants were recruited from all over Norway

from 1999 to 2008. The women consented to participation in 41% of the pregnancies. The cohort now includes 114,500 children, 95,200 mothers and 75,200 fathers.[25] The current study is based on version 7 of the quality-assured data files released for research.

The study cohort consisted of all 85,530 mother-infant dyads in MoBa who had delivered a singleton live-born infant and who had information available in the Medical Birth Registry of Norway (MBRN) as well as from 1 prenatal (Q1) and 1 postnatal (Q4) self-administered questionnaire (Figure 1). Thereafter, women who did not answer questions about breastfeeding duration, or who did not initiate breastfeeding were excluded, leaving a final cohort of 79,985.

The first questionnaire (Q1) was distributed during pregnancy (weeks 13–17) while the fourth (Q4) was sent at 6 months postpartum. English translations of the questionnaires can be found on the MoBa website (www.fhi.no/en/studies/moba/). The MoBa cohort is linked to pregnancy and birth records from the Medical Birth Registry (MBRN).

2.2 | Ascertainment of mastitis and related treatments

In Q4, administered 6 months postpartum, women were asked whether they had consulted a doctor, midwife or health visitor during the first month after delivery for 'mastitis'; we have called this 'early mastitis'. They were also asked to report whether they had experienced mastitis in the first 6 months postpartum, and whether they had received any medications to treat mastitis during months 0–3 or 4–6. Data were not collected on exact timing of mastitis, nor the number of episodes. We made the assumption that those reporting experiencing mastitis within the first month postpartum who also reported taking medications for mastitis during months 0–3, took those medications at the time of the first episode of mastitis.

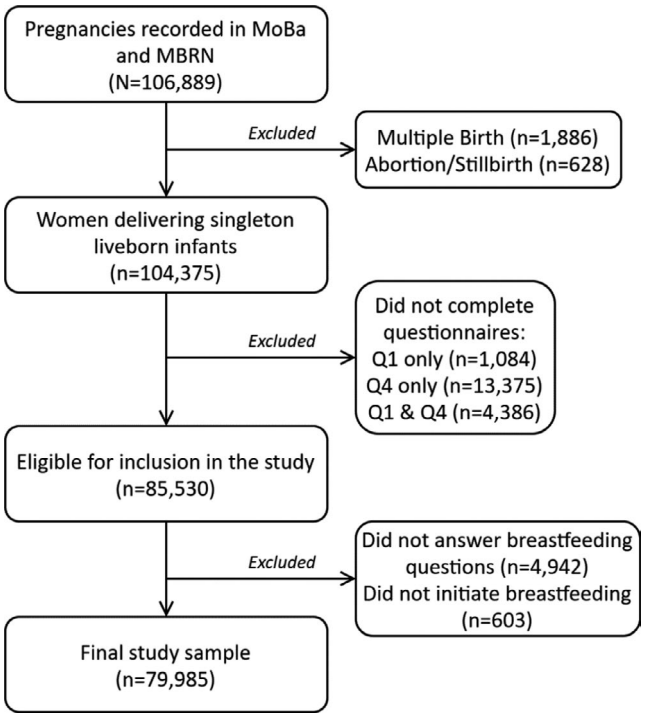

FIGURE 1 Study flow chart

Medications to treat mastitis were re-coded from free-text responses of medication names and classified according to the Anatomical Therapeutic Chemical (ATC) Classification System developed by World Health Organization (WHO).[26] Antibiotics were identified using the following 2nd level ATC codes; J01, J04. We also used the 3rd/4th and 5th level of ATC codes to identify specific therapeutic/chemical subgroup, and chemical/generic name of antibiotics. Some women reported antibiotic use without specifying the generic name or chemical group which was denoted by 'E000003'. As part of a *post hoc* analysis, oxytocin was identified using the ATC code H01BB02.[8] No information was available on formulation, dose or treatment duration.

Based on these responses, women were classified according to timing of first onset of mastitis (eg within first month vs. month one to six following delivery). We also classified women according to timing of first onset of mastitis and reported antibiotic use.

2.3 | Ascertainment of breastfeeding outcomes

Data on the infant feeding variables came from Q4 administered at 6 months postpartum. The three questionnaire items used in this analysis described (1) infant feeding during the first week after birth; (2) the kinds of liquids that the infant received at months 0, 1, 2, 3, 4, 5 and 6; and (3) in which month complementary food was introduced. We evaluated the report of predominant or any breastfeeding for 4 and 6 months postpartum, as well as abrupt breastfeeding cessation.

Categorisation of feeding is described in Ystrom et al.[27] We could not define exclusive breastfeeding because not all versions of the questionnaire included questions about use of water, water-based drinks and fruit juice beyond the first week of infant's life. Breastfeeding practices were classified as:

No breastfeeding

Women who fed their infants only with an infant formula or other milk or solid food; *Partial/mixed breastfeeding*: women who fed their infants with breast milk along with any infant formula or other milk and/or solid food; *Predominant breastfeeding*: women who fed their infants with breast milk only without using any infant formula or other milk and/or solid food; *Any breastfeeding*: this includes both full/predominant and partial breastfeeding at 6 months. In our analysis, *abrupt breastfeeding cessation* was defined as cessation of predominant and any breastfeeding within the same month postpartum.

2.4 | Ascertainment of mental health postpartum

In Q4 at 6 months postpartum, women were asked if they had suffered from any mental health problems after birth (yes/no). Severity of

maternal depressive and anxiety symptoms postpartum was also measured using the short version of The Hopkins Symptom Checklist_25 (SCL-25), namely, the 8-item (SCL-8).[28] Scores were averaged across the eight items. Women at risk for depression/anxiety were identified as those scoring ≥1.75.[29] Standardised z-scores were also computed.

2.5 | Covariates

Maternal age, pre-pregnancy BMI (underweight or <18.5 kg/m^2, normal weight or 18.5–25 kg/m^2 or overweight >25 kg/m^2 according to WHO guidelines), education (primary or secondary vs. university or higher), marital status (married or cohabiting vs. other), and parity (multiparous vs. primiparous) were all ascertained by self-report on Q1. Smoking (ever during pregnancy vs. not during pregnancy) was ascertained by combining information from self-report and linkage to the MBRN. Method of delivery (vaginal vs. Caesarean) and preterm birth (delivery <37 weeks' completed gestation) were ascertained from the MBRN. The presence of nipple pain or other breastfeeding problems and receiving support for this within the first month postpartum were ascertained by self-report on Q4.

History of mental health problems in the antenatal period was ascertained using data on the presence of psychiatric illness in Q1, or mental health problems during late pregnancy reported in Q4. Lifetime history of major depression (LTH of MD) was measured in Q1 via 5 key depressive symptoms closely corresponding to the DSM-III criteria for lifetime major depression.[30]

2.6 | Statistical methods

The association between mastitis and use of antibiotics and breastfeeding outcomes was evaluated using a generalised linear model (Poisson distribution) with robust variance estimates, generating relative risks (RR) and 95% confidence intervals (CI). Analyses of breastfeeding outcomes were adjusted for putative confounders including marital status, maternal age, BMI at conception, education, parity, smoking status in pregnancy, income, receipt of support for breastfeeding problems in the first month postpartum, preterm birth and Caesarean delivery. Analyses of postpartum mental health problems were adjusted for putative confounders including lifetime history of depression, marital status, maternal age, BMI at conception, education, parity, smoking status in pregnancy, income, receipt of support for breastfeeding problems in the first month postpartum, preterm birth, and Caesarean delivery. We also conducted a sensitivity analysis restricting the analysis to those participating in MoBa for the first time. All statistical analyses were undertaken using STATA SE 16 (Stata, College Station, Texas).

2.7 | Missing data

We explored the extent and patterns of missing data on covariates of interest between women with and without mastitis. Missing data on individual confounding variables ranged from less than 1% to 3.1%, leading to 6% of the study cohort having missing data information in at least one covariate. We explored the distribution of key variables in relation to missingness, but no specific pattern of missingness was evident (Table S1). All adjusted analyses were performed as complete case analyses among those without missing data.

3 | RESULTS

Among the total cohort of 79,985 mother-infant dyads, 6315 (7.9%) women reported first experiencing mastitis within the first month postpartum, while a further 8699 (10.9%) reported first experiencing mastitis during months 1–6 postpartum. Baseline sociodemographic, lifestyle and health characteristics of the study sample according to timing of lactational mastitis are shown in Table 1. There were relatively few differences between women who did and did not report experiencing mastitis at either time period.

A summary of antibiotic use according to timing of mastitis is presented in Table 2. Use of antibiotics was more common among those experiencing mastitis within the first month postpartum compared with those experiencing mastitis in the first 6 months postpartum. Patterns of antibiotic use were similar irrespective of timing, with penicillins most common and accounting for greater than 50% of use.

3.1 | Breastfeeding outcomes

The unadjusted and adjusted differences in breastfeeding outcomes according to timing of mastitis and treatment with antibiotics are presented in Table 3. Compared with women who did not experience mastitis during the first 6 months postpartum, those who experienced mastitis within the first month postpartum were less likely to report predominant breastfeeding for 6 months (aRR 0.92, 95% CI 0.86, 0.99), and any breastfeeding at 6 months (aRR 0.97, 95% CI 0.96, 0.98), while they were more likely to report abrupt breastfeeding cessation prior to 6 months (aRR 1.37, 95% CI 1.23, 1.53). First-onset mastitis between 1 and 6 months postpartum was not associated with poorer breastfeeding outcomes. In contrast, an increased risk for abrupt breastfeeding cessation was identified among women reporting mastitis and antibiotic use compared with women who did not experience mastitis. Restricting the analysis to the first participation in MoBa (Table S2) resulted in no appreciable changes in the risk estimates.

Among the cohort of 15,014 women who reported experiencing mastitis in the first 6 months postpartum and provided data on treatment, 5363 (35.7%) reported use of antibiotics alone, 289 (1.9%) the use of oxytocin nasal spray alone and 161 (1.1%) the combined use of antibiotics and oxytocin. Unadjusted and adjusted differences in breastfeeding outcomes according to the use of antibiotics and/or oxytocin are presented in Table 4. Compared with those who reported no treatment, antibiotic use alone was associated with reduced likelihood of predominant breastfeeding for 6 months (aRR 0.92, 95% CI 0.84, 1.00) and any breastfeeding for 6 months (aRR 0.98, 95% CI

TABLE 1 Maternal characteristics according to first onset of lactational mastitis during the first six months postpartum

	Lactational mastitis		
	<1 month	1–6 months	Never
N	6315	8699	64,971
Background characteristics			
Age (y), mean ± SD	29.7 (4.4)	30.4 (4.4)	30.3 (4.5)
BMI (kg/m^2) at conception, *n* (%)			
<18.5	187 (3.0)	300 (3.5)	1848 (2.9)
18.5–25	4248 (68.8)	5919 (69.7)	41,485 (65.5)
≥25	1741 (28.2)	2276 (26.8)	20,033 (31.6)
Primiparous, *n* (%)	3249 (51.5)	3384 (51.5)	29,957 (46.1)
Married/cohabiting, *n* (%)	6081 (96.3)	8427 (96.9)	62,548 (96.3)
University/College Education Level, *n* (%)	4318 (68.7)	6011 (69.0)	42,175 (65.2)
Woman's gross yearly income, USD *n* (%)			
Low (≤17,500 USD)	1119 (18.2)	1449 (17.2)	10,824 (17.2)
Average (17,501–46,800 USD)	4280 (69.7)	5923 (70.3)	44,748 (71.1)
High (≥46,801 USD)	741 (12.1)	1059 (15.6)	7325 (11.7)
Smoking Status at GW 30, *n* (%)			
No	5078 (80.6)	7194 (82.9)	50,361 (77.7)
Yes	316 (5.0)	437 (5.0)	5357 (8.3)
Stopped in pregnancy	908 (14.4)	1051 (12.1)	9131 (14.1)
Pregnancy-related characteristics			
Caesarean delivery, *n* (%)	806 (12.8)	1002 (11.5)	9007 (13.9)
Preterm birth, *n* (%)	234 (3.7)	327 (3.8)	3002 (4.6)
Mental health measures			
Lifetime history of major depression (yes), *n* (%)	432 (7.0)	525 (6.2)	3748 (5.9)
Antenatal mental health problems, *n* (%)	488 (7.7)	670 (7.7)	4428 (6.8)
Postnatal mental health problems, *n* (%)	419 (6.6)	465 (5.4)	2877 (4.4)
Depression/anxiety symptoms at 6 months postpartum (HSCL–8), z-score ±SD	0.05 (1.02)	0.05 (1.02)	−0.02 (0.98)
Breastfeeding problems			
Sought help for breastfeeding problems in first month after birth, *n* (%)	1300 (20.6)	426 (4.9)	2947 (4.5)
Sought help for sore nipples in first month after birth, *n* (%)	1617 (25.6)	401 (4.6)	2608 (4.0)

Abbreviations: BMI, body mass index; GW, Gestational Week; HSCL, Hopkins Symptom Checklist; maternal education, $n = 325$, income, $n = 2517$, smoking status, $n = 152$, lifetime history of depression, $n = 1936$; preterm birth, $n = 308$; SD, standard deviation. Numbers do not always add up due to missing numbers: BMI, $n = 1948$.

TABLE 2 Antibiotics for treatment of lactational mastitis according to timing of onset during the first six months postpartum

	First-onset mastitis[a]		Total
	<1 month (N = 6315)	1–6 months (N = 8699)	0–6 months (N = 15,014)
Use of any antibiotics	3068	2081	5524
Antibiotic class			
Penicillin (J01C)	1644 (53.6)	1153 (55.4)	2950 (19.6)
Macrolide (J01F)	299 (9.7)	204 (9.8)	534 (9.7)
Cephalosporin (J01D)	59 (1.9)	28 (1.3)	90 (1.6)
Other	32 (1.0)	15 (0.7)	53 (1.0)
Unknown	1130 (36.8)	693 (33.3)	2005 (36.3)
Multiple antibiotics	267 (8.7)	94 (4.5)	382 (6.9)

[a]Timing of antibiotic use missing for 575 women.

0.96, 0.99), as well as an increased likelihood of abrupt breastfeeding cessation prior to 6 months (aRR 1.17, 95% CI 1.01, 1.36). In contrast, oxytocin use alone or in combination with antibiotics was associated with an increased likelihood of any breastfeeding for 6 months (aRR 1.09, 95% CI 1.06, 1.12 and aRR 1.06, 95% CI 1.01, 1.12, respectively) and reduced likelihood of abrupt breastfeeding cessation prior to 6 months (aRR 0.33, 95% CI 0.13, 0.92 and aRR 0.29, 95% CI 0.07, 1.17, respectively).

3.2 | Mental health postpartum

The unadjusted and adjusted differences in postnatal mental health status according to timing of mastitis and treatment with antibiotics are presented in Table 5. Women who experienced mastitis within the

TABLE 3 Association between mastitis separated according to first onset and treatment with antibiotics and breastfeeding outcomes

		Predominant breastfeeding for 6 months postpartum			Any breastfeeding for 6 months postpartum			Abrupt breastfeeding cessation prior to 6 months postpartum		
	Total	*n* (%)	Unadjusted RR (95% CI)	Adjusted[b] RR (95% CI)	*n* (%)	Unadjusted RR (95% CI)	Adjusted[b] RR (95% CI)	*n* (%)	Unadjusted RR (95% CI)	Adjusted[b] RR (95% CI)
First-onset mastitis										
Never	64,971	9605 (14.8)	1.00 (Reference)	1.00 (Reference)	54,849 (84.4)	1.00 (Reference)	1.00 (Reference)	3027 (4.7)	1.00 (Reference)	1.00 (Reference)
<1 month	6315	802 (12.7)	0.86 (0.80, 0.92)	0.92 (0.86, 0.99)	5100 (80.8)	0.96 (0.94, 0.97)	0.97 (0.96, 0.98)	422 (6.7)	1.47 (1.33, 1.63)	1.37 (1.23, 1.53)
1–6 months	8699	1405 (16.2)	1.09 (1.04, 1.15)	1.02 (0.97, 1.08)	7819 (89.9)	1.06 (1.06, 1.07)	1.04 (1.04, 1.05)	338 (3.9)	0.84 (0.75, 0.94)	0.92 (0.82, 1.03)
First-onset mastitis and antibiotic treatment[a]										
Never	64,971	9605 (14.8)	1.00 (Reference)	1.00 (Reference)	54,849 (84.4)	1.00 (Reference)	1.00 (Reference)	3027 (4.7)	1.00 (Reference)	1.00 (Reference)
<1 month										
No antibiotics	3247	405 (12.5)	0.83 (0.76, 0.92)	0.91 (0.83, 1.00)	2617 (80.6)	0.95 (0.94, 0.97)	0.98 (0.96, 1.00)	228 (7.0)	1.53 (1.34, 1.76)	1.34 (1.16, 1.54)
Antibiotics	3068	397 (13.0)	0.88 (0.80, 0.97)	0.94 (0.85, 1.03)	2483 (80.9)	0.96 (0.94, 0.97)	0.96 (0.95, 0.98)	194 (6.3)	1.40 (1.21, 1.62)	1.41 (1.22, 1.64)
1–6 months										
No antibiotics	6660	1103 (16.6)	1.12 (1.06, 1.19)	1.04 (0.98, 1.10)	5995 (90.0)	1.07 (1.06, 1.07)	1.04 (1.04, 1.05)	251 (3.7)	0.81 (0.71, 0.93)	0.89 (0.78, 1.01)
Antibiotics	2039	302 (14.8)	1.00 (0.90, 1.11)	0.96 (0.86, 1.07)	1824 (89.5)	1.06 (1.04, 1.08)	1.04 (1.03, 1.06)	87 (4.3)	0.92 (0.74, 1.14)	1.02 (0.82, 1.26)
Ever mastitis and antibiotic treatment (0–6 months)										
Never	64,971	9605 (14.8)	1.00 (Reference)	1.00 (Reference)	54,849 (84.4)	1.00 (Reference)	1.00 (Reference)	3027 (4.7)	1.00 (Reference)	1.00 (Reference)
Mastitis +No Antibiotics	9490	1459 (15.43)	1.04 (0.99, 1.10)	1.01 (0.96, 1.07)	8264 (87.1)	1.03 (1.02, 1.04)	1.03 (1.02, 1.03)	454 (4.8)	1.04 (0.94, 1.15)	1.04 (0.94, 1.15)
Mastitis +Antibiotics	5524	748 (13.6)	0.92 (0.85, 0.98)	0.93 (0.87, 1.00)	4655 (84.4)	1.00 (0.98, 1.01)	1.00 (0.99, 1.01)	306 (5.5)	1.22 (1.08, 1.37)	1.25 (1.11, 1.42)

Note: Predominant breastfeeding: Women who fed their infants with breast milk only without using any infant formula or other milk and/or solid food; Any breastfeeding: This includes both full/predominant and partial breastfeeding at 6 months; Abrupt breastfeeding cessation: Cessation of predominant and any breastfeeding within the same month postpartum.

[a]Timing of antibiotic use missing for 575 women.

[b]Adjusted for marital status, maternal age, BMI at conception, education, parity, smoking status in pregnancy, income, receipt of support for breastfeeding problems in the first month postpartum, preterm birth, Caesarean delivery and antenatal mental health problems.

TABLE 4 Association between treatment of mastitis with antibiotics and/or oxytocin and breastfeeding outcomes among women reporting mastitis within the first 6 months postpartum

		Predominant breastfeeding for 6 months postpartum,			Any breastfeeding for 6 months postpartum			Abrupt breastfeeding cessation prior to 6 months postpartum		
	Total	*n* (%)	Unadjusted RR (95% CI)	Adjusted[a] RR (95% CI)	*n* (%)	Unadjusted RR (95% CI)	Adjusted[a] RR (95% CI)	*n* (%)	Unadjusted RR (95% CI)	Adjusted[a] RR (95% CI)
Mastitis treatment										
No antibiotic or oxytocin use	9201	1410 (15.4)	1.00 (Reference)	1.00 (Reference)	7987 (86.8)	1.00 (Reference)	1.00 (Reference)	450 (4.9)	1.00 (Reference)	1.00 (Reference)
Antibiotics alone	5363	729 (13.6)	0.88 (0.81, 0.96)	0.92 (0.84, 1.00)	4508 (84.1)	0.97 (0.95, 0.98)	0.98 (0.96, 0.99)	304 (5.7)	1.17 (1.01, 1.36)	1.17 (1.01, 1.36)
Oxytocin alone	289	49 (17.0)	1.08 (0.82, 1.42)	1.04 (0.79, 1.36)	277 (95.9)	1.10 (1.07, 1.13)	1.09 (1.06, 1.12)	4 (1.4)	0.31 (0.11. 0.81)	0.33 (0.13, 0.89)
Antibiotics and oxytocin	161	19 (11.8)	0.80 (0.52, 1.22)	0.84 (0.55, 1.29)	147 (91.3)	1.06 (1.01, 1.11)	1.06 (1.01, 1.12)	2 (1.2)	0.27 (0.07, 1.06)	0.29 (0.07, 1.17)

Note: Predominant breastfeeding: Women who fed their infants with breast milk only without using any infant formula or other milk and /or solid food; Any breastfeeding: This includes both full/predominant and partial breastfeeding at 6 months; Abrupt breastfeeding cessation: Cessation of predominant and any breastfeeding within the same month postpartum.

[a]Adjusted for marital status, maternal age, BMI at conception, education, parity, smoking status in pregnancy, income, receipt of support for breastfeeding problems in the first month postpartum, preterm birth, Caesarean delivery and antenatal mental health problems.

first month or 1–6 months postpartum were more likely to report experiencing postnatal mental health problems (aRR 1.24, 95% CI 1.11, 1.37 and aRR 1.20, 95% CI 1.09, 1.31, respectively) and were more likely to be classified above the cut-off score according to the Hopkins Symptom Checklist (aRR 1.11, 95% CI 1.02, 1.22 and aRR 1.10, 95% CI 1.02, 1.19, respectively). When stratified by antibiotic use, the association between mastitis and poorer maternal mental health was only evident among those reporting no antibiotic use.

4 | COMMENT

4.1 | Principal findings

In this cohort study of 79,985 breastfeeding women followed for the first 6 months postpartum, 18.8% self-reported lactational mastitis at least once, with 37% reporting treatment with antibiotics. Our findings suggest that women who experience mastitis within the first month postpartum, but not those who experience it within months 1–6, are at risk of abrupt breastfeeding cessation and are less likely to be able to sustain *predominant* or *any* breastfeeding for 6 months. The combination of mastitis and antibiotic use was associated with an increased risk of abrupt breastfeeding cessation. Irrespective of timing, we identified an association between mastitis and poorer maternal mental health. However, the association between mastitis and poorer maternal mental health was only evident among those reporting mastitis without antibiotic use and not mastitis with antibiotic use.[21]

4.2 | Strengths of the study

We used a high-quality data set from a large prospective cohort study from Norway where breastfeeding is established as the norm. We controlled for a number of covariates to minimise the effects of confounding. The separation of mastitis according to timing of onset reflects a key strength of this study and provides stronger evidence for its likely impact on breastfeeding outcomes.

4.3 | Limitations of the data

Mastitis was self-reported, and no definition was provided to mothers to assist with reporting. Further, data related to exact timing of mastitis or number of occurrences were not collected, nor were data on the exact timing of antibiotic use. In addition, 36% of women reported antibiotic use without specifying the name of the antibiotic, limiting the ability to analyse outcomes according to type of antibiotic. Although the MoBa is a prospective cohort study, given questionnaires are completed in a retrospective manner we cannot rule out the possibility of recall bias. Lastly, MoBa questionnaires did not collect detailed information regarding receipt of breastfeeding support which could influence the likelihood of mastitis occurring and its associated outcomes.

TABLE 5 Association between mastitis separated according to first onset and treatment with antibiotics and mental health problems in the postnatal period

		Self-reported mental health Problems Postpartum[a]			Above cut-off on Hopkins Symptom Checklist (SCL–8) 6 months postpartum[b]		
	Total	*n* (%)	Unadjusted RR (95% CI)	Adjusted[d] RR (95% CI)	*n* (%)	Unadjusted RR (95% CI)	Adjusted[d] RR (95% CI)
First-onset mastitis							
Never	64,971	2877 (4.4)	1.00 (Reference)	1.00 (Reference)	4950 (8.4)	1.00 (Reference)	1.00 (Reference)
<1 month	6315	419 (6.6)	1.50 (1.35, 1.66)	1.24 (1.11, 1.37)	600 (10.4)	1.21 (1.11, 1.31)	1.11 (1.02, 1.22)
1–6 months	8699	465 (5.4)	1.22 (1.10, 1.34)	1.20 (1.09, 1.31)	722 (9.4)	1.10 (1.02, 1.19)	1.10 (1.02, 1.19)
First-onset mastitis and antibiotic treatment[c]							
Never	64,971	2877 (4.4)	1.00 (Reference)	1.00 (Reference)	4950 (8.4)	1.00 (Reference)	1.00 (Reference)
<1 month							
No antibiotics	3247	232 (7.2)	1.63 (1.42, 1.86)	1.32 (1.16, 1.50)	333 (11.2)	1.32 (0.19, 1.48)	1.17 (1.05, 1.31)
Antibiotics	3068	187 (6.1)	1.36 (1.17, 1.58)	1.15 (0.99, 1.33)	267 (9.5)	1.10 (0.97, 1.24)	1.06 (0.94, 1.20)
1–6 months							
No antibiotics	6660	382 (5.7)	1.30 (1.17, 1.45)	1.29 (1.16, 1.43)	569 (9.6)	1.14 (1.04, 1.24)	1.14 (1.05, 1.24)
Antibiotics	2039	83 (4.1)	0.94 (0.75, 1.17)	0.91 (0.74, 1.11)	153 (8.4)	1.02 (0.97, 1.20)	1.06 (0.90, 1.23)
Ever mastitis and antibiotic treatment (0–6 months)							
Never	64,971	2877 (4.4)	1.00 (Reference)	1.00 (Reference)	4950 (8.4)	1.00 (Reference)	1.00 (Reference)
Mastitis & no antibiotics	9490	583 (6.1)	1.40 (1.27, 1.53)	1.29 (1.18, 1.41)	857 (10.1)	1.18 (1.09, 1.27)	1.13 (1.05, 1.21)
Mastitis and antibiotics	5524	301 (5.5)	1.23 (1.09, 1.39)	1.08 (0.96, 1.22)	465 (9.3)	1.09 (0.99, 1.20)	1.06 (0.97, 1.17)

[a]Based on maternal self-report at 6 months postpartum.

[b]Women scoring ≥1.75, measured at 6 months postpartum.

[c]Timing of antibiotic use missing for 575 women.

[d]Adjusted for antenatal mental health problems, lifetime history of depression, marital status, maternal age, BMI at conception, education, parity, smoking status in pregnancy, income, receipt of support for breastfeeding problems in the first month postpartum, preterm birth and Caesarean delivery.

4.4 | Interpretation

The reported incidence of mastitis in this study (18.8%) is within the range of that reported in previous international studies (2.5%–23.7%).[4] The higher incidence compared with some studies likely relates to the higher rates of breastfeeding seen in Norway, collection of data on mastitis irrespective of disease severity, and the longer follow-up of women until 6 months postpartum, and is similar to estimates from Australia.[5,31] Data on the prevalence of antibiotic use for mastitis remain limited, with Vogel et al reporting a rate of 68% based on a New Zealand cohort of 83 women who reported experiencing mastitis in the first-year postpartum.[13] In contrast, we observed a lower prevalence of antibiotic use of 50.9% among those with mastitis in the first month postpartum, and 38.2% among those with mastitis any time in the first 6 months' postpartum. Reasons for the differences in prescribing patterns of antibiotics are unclear, but could relate to regional variation in antibiotic use, or differences in clinical recognition and adoption of clinical practice guidelines for the management of mastitis.

Our finding that early-onset mastitis is associated with premature cessation of breastfeeding is supported by a number of previous studies.[9,10,32] That said, the absolute effects of mastitis on breastfeeding outcome appear small. Our observed associations between early mastitis and poorer breastfeeding outcomes correspond to absolute reductions of 2.5% and 1.2% in terms of the number of women reporting any or predominant breastfeeding for 6 months. In contrast, mastitis occurring beyond 1 month postpartum was possibly associated with longer duration of breastfeeding, but such findings are likely biased given the at-risk interval for experiencing mastitis is greater the longer a woman breastfeeds. In clinical practice, women experiencing mastitis in later months often have an oversupply of milk which promotes continued breastfeeding and could explain the association of longer duration in women with mastitis after 1 month.[5]

We are not aware of previous studies that have analysed breastfeeding outcomes in women experiencing mastitis according to treatment with antibiotics. An observed higher likelihood of abrupt breastfeeding cessation among women who used antibiotics for mastitis could relate to possible concerns about the negative impacts of antibiotic use during breastfeeding, or differences in mastitis severity requiring treatment with antibiotics.

Maternal and clinician concerns regarding medicine use in lactation are commonly reported in the literature,[33–36] and confirmed in a recent interview study with Norwegian women who reported that some clinicians were overly restrictive about medications in lactation.[37]

The increased likelihood of maternal mental health problems in women reporting mastitis is consistent with previous literature demonstrating the debilitating effects of mastitis on women's mental health.[20–22] Differences in mental health outcomes may also be tied, indirectly, to breastfeeding cessation, which has been previously shown in MoBa to be a risk factor for increased symptoms of anxiety and depression.[38] Further, the observed differences in mental health outcomes according to whether women with mastitis received treatment with antibiotics are of interest and may reflect the positive effects of engaging with and receiving treatment and/or support from healthcare providers. While findings were adjusted for antenatal mental health problems and lifetime history of depression, the possibility of reverse causation cannot be ruled out, in that postpartum mental health problems could have preceded the development of mastitis. There is some evidence that maternal stress and sleep deprivation could increase sensitivity of the breast to inflammatory stimuli and increase risk of mastitis[39]; however, this notion requires further study.

The findings related to use and effects of oxytocin for mastitis management were unexpected. In Norway, clinical practice guidelines refer to the use of oxytocin as a supporting treatment for the management of mastitis,[8] but data on uptake on use have not been previously published. It is possible that observed differences in those treated with oxytocin may reflect differences in disease severity compared with women treated with antibiotics. Notably, effect estimates for these findings were imprecise and therefore challenging to interpret. Further, the inclusion of data on oxytocin use was undertaken *post hoc*. Irrespectively, these findings warrant further investigation given the possibility it could alleviate the significant maternal morbidity associated with mastitis.

The implications for clinical practice include increased attention to early breastfeeding support and awareness among clinicians of the potential impact of mastitis on women's mental health.[37] Although primarily a physical condition, mastitis may be a negative emotional experience for mothers in the early postpartum period.[21] Future research needs to clearly define lactational mastitis and be conducted into prevention and treatment of mastitis with outcome measures including women's mental health and breastfeeding practices.

5 | CONCLUSIONS

Lactational mastitis and its associated treatment with antibiotics are common during the first 6 months postpartum. We found that women experiencing mastitis within the first month postpartum, but not later, may be at greater risk of suboptimal breastfeeding outcomes including abrupt breastfeeding cessation. Further, whether or not mastitis was treated with antibiotics did not appear to influence breastfeeding outcomes. Irrespective of timing, mastitis was associated with poorer mental health. Clinicians need to understand and acknowledge the impact of mastitis on new mothers and provide timely holistic support to enable women to meet their breastfeeding goals.[21] Guidelines for care of women in the postpartum period should support breastfeeding and mental health concurrently and avoid the current silo approach to the care of postpartum women.

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CONFLICT OF INTERESTS

The authors declare they have no competing interests.

ETHICAL APPROVAL

MoBa has obtained a licence from the Norwegian Data Inspectorate (01/4325) and approval from the Regional Committee for Medical Research Ethics (S-97045, S-95113). Ethics approval was also obtained from the Human Ethics Committee, La Trobe University, Australia (No. FHEC13/015). All participants gave written informed consent before participation.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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