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Impact of the Thompson method on breastfeeding exclusivity and duration: Multi-method design

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ABSTRACT

Background: How hospital clinicians facilitate breastfeeding in the first 48–72 h is critical to breastfeeding exclusivity and duration. Mothers who discharge hospital directly breastfeeding are more likely to continue exclusively breastfeeding at 3-months.
Objective: To assess the impact of facility-wide implementation of a physiological breastfeeding method (the Thompson method) on direct breastfeeding at hospital discharge and exclusive breastfeeding at 3-months of age.
Design: Multi-method design using interrupted time series analysis and surveys.
Setting(s): An Australian tertiary maternity hospital.
Participants: 13,667 mother-baby pairs (interrupted time series analysis) and 495 postnatal mothers (surveys).
Methods: The Thompson method includes cradle position and hold, alignment of mouth-to-nipple, baby-led connection and seal, maternal fine-tuning for symmetry, and leisurely duration. We used a large pre-post implementation dataset and conducted interrupted time series analysis using a 24-month baseline period (January 2016 – December 2017); and a 15-month post-implementation period (April 2018 – June 2019). We recruited a sub-sample of women to complete surveys at hospital discharge and 3-months postpartum. Surveys were primarily used to measure impact of Thompson method on exclusive breastfeeding at 3-months, compared with a baseline survey conducted in same setting.
Results: Following implementation of the Thompson method, the declining trend in direct breastfeeding at hospital discharge was significantly averted by 0.39% each month relative to baseline (95% CI: 0.03% to 0.76%; $p = 0.037$). While the 3-month exclusive breastfeeding rate in the Thompson group was 3 percentage points higher than the baseline group; this result did not reach statistical significance. However, a subgroup analysis of women who discharged hospital exclusively breastfeeding revealed the relative odds of exclusive breastfeeding at 3-months in the Thompson group was 0.25 (95% CI: 0.17 to 0.38; $p < 0.001$), significantly better than the baseline group ($Z = 3.23$, $p < 0.01$) where the relative odds was only 0.07 (95% CI: 0.03 to 0.19; $p < 0.001$).
Conclusions: Implementation of the Thompson method for well mother-baby pairs improved direct breastfeeding trends at hospital discharge. For women who discharged hospital exclusively breastfeeding, exposure to the Thompson method reduced the risk of exclusive breastfeeding discontinuation by 3-months. The positive impact of the method was potentially confounded by partial implementation and a parallel rise in birth interventions which undermine breastfeeding. We recommend strategies to strengthen clinician buy-in to the method, and future research using a cluster randomised trial design.
Tweetable abstract: Facility-wide implementation of the Thompson method improves direct breastfeeding at hospital discharge and predicts breastfeeding exclusivity at 3-months.

What is already known

- Exclusive breastfeeding is a public health priority, but most women discontinue before 3-months
- While physiological breastfeeding methods have shown promising results, they are not widely used and are under-researched

What this paper adds

- This implementation study found that the Thompson method improves direct breastfeeding (infant suckling directly from the breast only) at hospital discharge

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- For women who discharged hospital exclusively breastfeeding, the Thompson method predicted continuation of exclusive breastfeeding at 3-months, compared to women not exposed to the method

1. Background

Breastfeeding is an international public health priority (Theurich et al., 2019). There are significant health, environmental, and cost benefits associated with breastfeeding (Rollins et al., 2016). For children, breastfeeding reduces the risk of sudden infant death, infection (gastrointestinal, respiratory tract, middle ear), overweight/obesity, and diabetes (Victora et al., 2016). For women, breastfeeding reduces the risk of breast and ovarian cancer, and of developing Type 2 diabetes (Victora et al., 2016). While the greatest child health benefits result from exclusive breastfeeding (breast or breastmilk only), *any* breastmilk is superior to not breastfeeding because a dose/response relationship has been established (Raisler et al., 1999; Scariati et al., 1997). Globally, the $302 billion annual economic losses associated with not breastfeeding derive from the impact of lower cognition on educational attainment and potential future earnings; and direct healthcare costs associated with childhood morbidity (Rollins et al., 2016).

1.1. Exclusive breastfeeding in high-income countries

High-income countries continue to fall short of the World Health Organization (WHO) recommendation that babies should be exclusively breastfed until six months of age, and continue to breastfeed for 2-years and beyond, alongside the introduction of appropriate foods (Vaz et al., 2021; World Health Organization, 2017a). Data from 51 high-income countries demonstrate the median rate of breastfeeding initiation is 91%, which falls to 18% exclusive breastfeeding and 29% any breastfeeding at 6 months of age (Vaz et al., 2021). In the WHO European region, exclusive breastfeeding rates at 6-months are among the lowest in the world at 25% (Theurich et al., 2019). In Australia, breastfeeding initiation is high (96%), but while 69% of infants are still receiving some breastmilk by <4-months of age, only 39% of infants are exclusively breastfeeding (Australian Institute of Health and Welfare, 2011). Further, while 60% of infants are receiving some breastmilk by <6-months of age, only 15% of infants are exclusively breastfeeding (Australian Institute of Health and Welfare, 2011). This decline occurs in parallel with rising exposure of babies to artificial formula: >50% at 3-months, >70% at 4-months, and >80% at 5-months (Australian Institute of Family Studies, 2008).

1.2. Clinician-led interventions to promote breastfeeding exclusivity and duration

Evidence from a cluster-randomised controlled trial demonstrates that clinician-led breastfeeding interventions (i.e., Baby Friendly Hospital Initiative) increase breastfeeding exclusivity at 3-months and 6-months, and the probability of any breastfeeding at 12-months (Kramer et al., 2001). Recent systematic review has demonstrated that clinician-led, multicomponent interventions (i.e., prenatal education combined with postnatal support; postnatal breastfeeding education sessions and support sessions; prenatal and postnatal lactation consultant intervention) can effectively increase the rate of exclusive breastfeeding at 6-months (Kim et al., 2018). Therefore, improving the way breastfeeding is supported during hospital postnatal care is a key concern (Malouf et al., 2019). Indeed, what occurs during the first 48 h after birth predicts breastfeeding at 3-months and 6-months of age. Avoiding artificial formula on the postnatal ward is associated with exclusive breastfeeding at 3-months (O'Connor et al. 2017). Avoiding both expressed breastmilk and artificial formula on the postnatal ward, by direct breastfeeding, increases the chance of any breastfeeding at 6-months (Forster et al., 2015).

1.3. Hands-off breastfeeding approaches

Physiological breastfeeding, sometimes referred to as baby-led, uses hands-off techniques that facilitate maternal instinctual behaviours and activation of neonatal reflexes (Colson et al., 2008). Commonly this includes use of a semi-reclined position for breastfeeding where baby's body is in full and close contact with mother's body, and baby's reflexes aid face to breast connection and establishment of seal (i.e., latch) (Colson et al., 2008). Physiological breastfeeding is compatible with the midwife's role to optimise psychophysiology during third stage labour to allow instinctual breastfeeding to occur (Hastie and Fahy, 2009). More accurately, the midwife avoids disrupting or undermining instinctual breastfeeding for the mother-baby pair. Randomised trial results show that baby-led attachment increased the likelihood of exclusive breastfeeding and reduced the chance of nipple pain at 3-days and 6-months postpartum (Yin et al., 2021).

1.4. Hands-on breastfeeding approaches

The primary breastfeeding method taught to women is cross-cradle hold combined with a sequence of attachment manoeuvres: re-shape the breast, align nipple to nose, stimulate baby's mouth to wide gape, then use rapid arm movement to bring baby to breast (UNICEF UK). In Australian hospitals, midwives commonly take the role of "expert" and teach women these complicated breastfeeding manoeuvres which interfere with an instinctual, physiological approach (Thompson et al., 2011). Surveyed Australian women who ceased breastfeeding reported: perception of insufficient breast milk (56%), an unsettled baby (25%), difficultly with attaching the baby to the breast (25%), or breastfeeding was too painful (18%) (Australian Institute of Health and Welfare, 2011). The reasons commonly cited by women for early cessation of breastfeeding are likely to have a root cause – the routine way positioning and attachment of the baby is taught and supported in hospital.

1.5. Development of the Thompson method

An Australian cross-sectional study of data collected 2003–2007 reported 62.9% (n = 411) of women who were referred by maternal child health nurses to a specialist breastfeeding consultant for in-home breastfeeding support were diagnosed with nipple trauma. A total of 85% (n = 552) were using cross-cradle hold and rapid arm movement whilst 88.4% were reshaping the breast and redirecting their nipple to the baby's nose (Thompson et al., 2016). Nipple trauma was statistically more likely to occur with asymmetrical face-to-breast attachment, in the presence of inflammatory mastitis, when nipple misalignment occurred, and when cross-cradle technique was used; after controlling for covariates (Thompson et al., 2016). Engorgement was associated with the first postpartum breastfeed being less than one-hour duration (Thompson et al., 2016). Following changes to the breastfeeding technique (called the Thompson method, see Table 1); 53% of participants reported an excellent improvement (reduced pain and increased comfort) during the first consultation, 29.2% were very satisfied and 8.6% had a good result with only 3.7% having only some improvement and 0.5% having none (Thompson, 2014). While there has been limited evaluation of the Thompson method, it is congruent with physiological breastfeeding practices which have been widely demonstrated to be beneficial in terms of nipple trauma and breastfeeding duration.

1.6. Objectives and hypotheses

The primary objective was to evaluate the effect of the Thompson method on breastfeeding at two time points: hospital discharge (direct breastfeeding) and 3-months postpartum (exclusive breastfeeding).

Table 1
Breastfeeding methods used pre- and post-implementation.

	Routine method (pre-implementation)	Thompson method (post-implementation)
Position & hold	• Mother uses cross-cradle or football hold • Mother/midwife holds the baby by the base of the head, neck, and shoulders 	• Mother cradles baby, in left arm (for left breast), right arm (for right breast) – cradle hold • Baby faces the breast while lying parallel hip to shoulder across the mother's body. • Mother avoids holding the baby's cranio-cervical spine 
Breast shaping	• Mother/midwife re-shapes the woman's breast	• No-one handles or shapes the woman's breast
Nipple alignment	• Mother/midwife directs nipple to baby's nose 	• Mother aligns baby to achieve lips central over nipple 
Connection & seal	• Mother/midwife observe for wide gaping mouth (special-K) • Mother/midwife applies forceful rapid arm movement to thrust baby onto the breast	• Mother gently guides her baby forward onto her breast so both cheeks are resting snug on her breast, no visible gaps. • Mother observes and senses her baby draw the nipple and breast to activate intra-oral vacuum
Adjustment	Mother/midwife inserts a finger into baby's mouth to break the oral seal and remove the baby before repeating process 	• Mother improves asymmetrical face-to-breast contact using the *fine-tuning technique* to achieve *symmetrical face-to-breast with four-points of appropriate contact* (cheeks, nostrils, chin) 
Timing	Baby may feed from one breast only or be advised to time feeds	• Baby feeds leisurely from both breasts until the cues of gastric satisfaction are observed. • Pausing after each breast to *rest and digest*
Midwife's role	Midwife uses hands-on approach (e.g., may shape woman's breast, direct her nipple to the baby's nose and/or place a hand on woman's hand to assist with rapid arm movement) to thrust baby onto breast	• Midwife optimises each woman and baby's instinctive skills and breastfeeding behaviours • Midwife uses hands-off approach – no handling of breast or baby • Midwife provides verbal guidance and feedback based on their observations

We hypothesised that following implementation; women would be more likely to discharge from hospital direct breastfeeding and be more likely to continue exclusively breastfeeding at 3-months. The secondary objective of this study was to determine the extent to which implementation had occurred.

2. Methods

2.1. Context and setting

The setting for the study was an Australian tertiary-level maternity hospital. The hospital was measuring a steady decline in breastfeeding rates over a decade, which was the impetus for this study. The hospital was not accredited with Baby Friendly Hospital Initiative (UNICEF and World Health Organization, 2009). In this setting, over 10,000 babies are born each year; 60% are publicly funded and 40% are private. The context for this study was the public setting only, which was physically segregated from the private setting within the hospital facility. The content of breastfeeding education and support is summarised above (Table 1). In the outpatient setting, midwives provide breastfeeding education during routine antenatal visits and through optional antenatal classes. Midwives provide postnatal breastfeeding education and support at home following early hospital discharge for up to two weeks (2–4 visits, standard care) or up to six weeks (6–10 visits), if receiving midwifery continuity of care (~30% of women in the public setting). In the inpatient setting, midwives support women and babies to breastfeed in birth suite or operating theatre, special care nursery, and the postnatal ward. If breastfeeding complications arise during the postnatal stay, women can attend daily breastfeeding education and feeding clinics led by lactation consultants. If women need further assistance, they can receive one-to-one assistance from a lactation consultant free-of-charge up to six months after birth. The median length of stay on the postnatal ward was 2-days, slightly shorter than the 3-day Australian average (Australian Institute of Health and Welfare, 2020). It is important to note that the national average includes privately insured women (who have longer lengths of stay).

2.2. Study design

We conducted a multi-method implementation study primarily to determine the impact of the Thompson method on breastfeeding exclusivity and duration. The study had two primary outcomes: direct breastfeeding (hospital discharge) and exclusive breastfeeding (3-months of age).

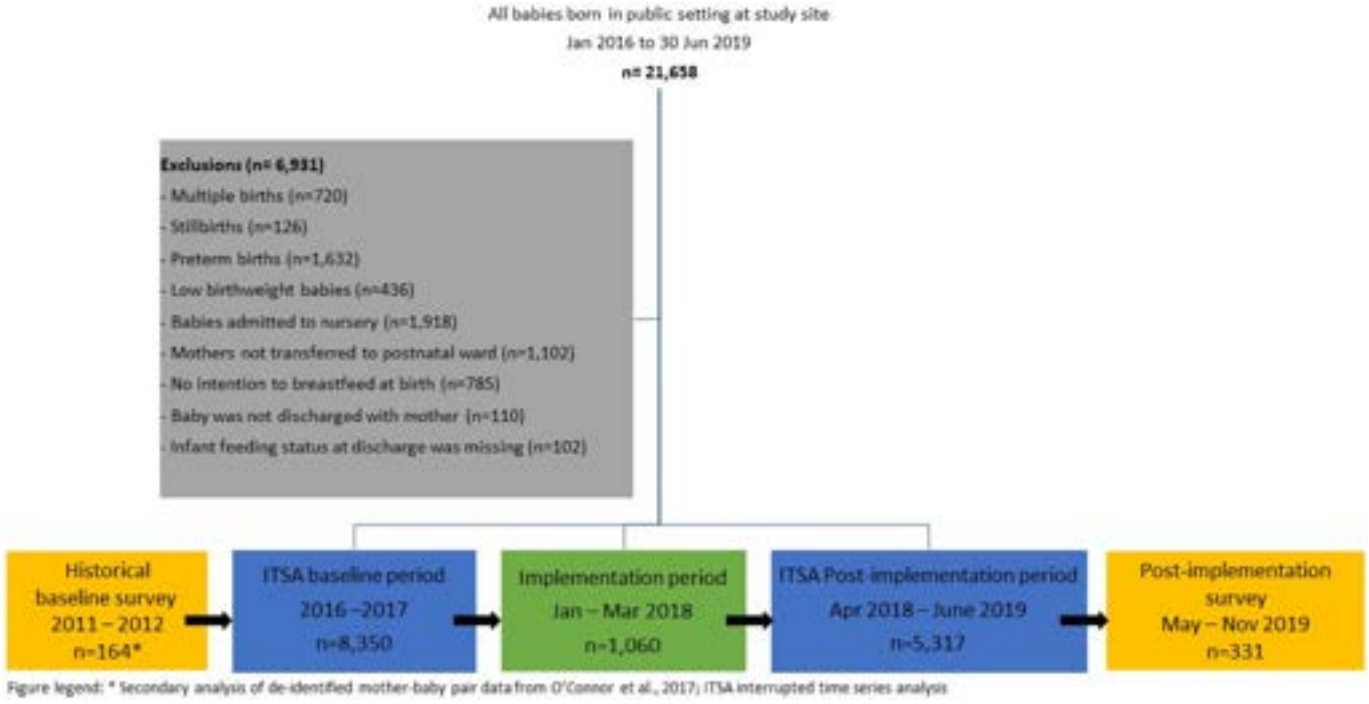

Fig. 1. Study participants and timeline.

2.2.1. Interrupted time series analysis

To investigate the effect of Thompson method on breastfeeding trends at hospital discharge, we used a large pre-post implementation dataset and conducted interrupted time series analysis (Fig. 1). Interrupted time series is considered one of the strongest quasi-experimental research designs, commonly used to test the effect of health policy changes when randomisation is unfeasible (Hudson et al., 2019). Using interrupted time series analysis enabled the researchers to determine whether data patterns observed post-intervention were significantly different to those observed pre-intervention (Hudson et al., 2019). For this reason, we used interrupted time series with a large dataset to measure the primary outcome of direct breastfeeding at hospital discharge.

2.2.2. Suveys

To investigate the effect of the Thompson method on infant feeding at 3-months, we recruited a sub-sample of women to complete surveys at hospital discharge and 3-months postpartum (Fig. 1). The discharge survey was designed to determine whether there was high-level uptake and compliance with the Thompson method. The 3-month survey was used to measure whether women exposed to the Thompson method had a higher rate of exclusive breastfeeding at 3-months compared to women not exposed to the Thompson method. Three-month survey data was compared through secondary analysis of de-identified data from a previous breastfeeding survey conducted by the study authors in the same setting, using the same infant feeding questions.

2.3. Routine methods versus Thompson method

Table 1 presents Thompson method of breastfeeding, including its' individual components, compared to usual approach in the research setting.

2.4. Implementation

We worked to implement Thompson method, to "make it happen" (Greenhalgh et al., 2004), using WHO guidance for successful implementation of pilot projects and planning for scale-up (World Health Organization, 2011). First, the project was co-designed with key stakeholders at all stages; from planning to implementation, to monitoring and evaluation (World Health Organization, 2011). Key stakeholders included the Director and Assistant Directors of Nursing and Midwifery; the managers of antenatal clinic, birth suite, postnatal ward, and lactation service; and lactation consultants. Second, the Thompson method was tailored to the hospital setting and key components were elucidated for simplicity. (Thompson et al., 2011) Third, the research plan and resource allocation included monitoring, documenting, and feeding back to clinicians and managers on implementation progress (Greenhalgh et al., 2004; World Health Organization, 2011).

The resource team included study investigators, the innovator of the method, and a research assistant. A dedicated research position was undertaken by a hospital lactation consultant and senior midwife (third author). This role was 0.7 full-time equivalent for 12-months during post-implementation to champion Thompson method through formal and informal channels, support lactation consultants and midwives trialling the method, monitor and record any changes at the hospital during the study period (e.g., policy changes), monthly audit and feedback on implementation progress, and recruit participants to complete surveys.

2.4.1. Pre-implementation phase

Lactation consultants completed a 4-hour train-the-trainer workshop delivered face-to-face by Dr. Robyn Thompson. During this period 2-hour twilight seminars were advertised for staff to observe Dr. Thompson completing a live consultation with a breastfeeding mother. An online learning package was developed.

2.4.2. Implementation phase

For clinicians, the 2-hour online-learning package was available and mandatory for midwives to complete within 3-months. The research assistant delivered 30-minute in-service sessions in every public area of the hospital. Annual mandatory education about breastfeeding aligned content with Thompson method. Dr. Robyn Thompson was available on-site to support midwives trialling the Thompson method, alongside trained lactation consultants. For women and families, content of all patient-facing breastfeeding materials were aligned with the Thompson method. Specifically, childbirth preparation classes, patient brochures, inpatient television included a 5-minute how-to Thompson method

video, and daily 45-minute breastfeeding talks on the postnatal ward taught the method as the first line approach.

2.4.3. Post-implementation phase

The research assistant conducted on-site monitoring on weekdays on use of the Thompson method, and monthly audit and feedback to managers and clinicians in each area based on patient discharge surveys.

2.5. Study population, variables, data collection

2.5.1. Interrupted time series analysis

Data from publicly insured mother-baby pairs were included in the interrupted time series analysis (ITSA) if the baby was: a singleton, liveborn, full-term, weighted ≥2500 g, and was transferred to the postnatal ward following birth at the study site. Data were excluded analysis where the infant was: a multiple, stillborn, preterm (<37 weeks' gestation), weighed <2500 g, or was not transferred to the postnatal ward following birth (i.e., discharged home or transferred to neonatal nursery), or did not discharge home with its' mother. We excluded participants who did not intend to breastfeed at birth or their feeding status at discharge was missing. Potential demographic confounders were maternal age, marital status, education status. Potential clinical confounders were onset of labour, regional analgesia, caesarean section, duration of skin-to-skin contact at birth, and breastfeeding initiation within 60-min of birth.

Routinely collected maternal and perinatal data was recorded primarily by midwives in an electronic database at hospital discharge. The primary outcome was direct breastfeeding (infant suckling directly from the breast only) at hospital discharge. Secondary infant feeding outcomes at hospital discharge were exclusive breastfeeding (breast or breastmilk only), partial breastfeeding (breastfeeding and artificial formula), artificial feeding (only artificial formula). Secondary maternal outcomes at hospital discharge were nipple trauma and poor attachment (both subjectively determined by discharge midwife).

2.5.2. Surveys

2.5.2.1. Recruitment. Potentially eligible women for survey participation were those who had given birth in the study hospital following implementation of the Thompson method, during the recruitment period (January–August 2019). Inclusion criteria were women that spoke English, who were feeding their baby any breastmilk, with a baby that was a singleton, liveborn, full-term, weighted ≥2500 g, and not admitted to a separate neonatal nursery. Midwives on the public postnatal ward screened, and briefly discussed the study, with potentially eligible women each weekday. The research assistant would approach eligible and interested women with a copy of the Participant Information and Consent Form to consider and ask questions. The research assistant obtained written informed consent and completed a recruitment form.

2.5.2.2. Survey at hospital discharge. Fidelity to the Thompson method (a measure of implementation success) was collected from survey collected prior to hospital discharge. These included which of the Thompson components were used to breastfeed (always, most times, sometimes, never); perceptions of midwifery support for breastfeeding (Likert scale); whether baby received any expressed breastmilk or artificial milk prior to discharge (yes/no; perceived reason); women's breastfeeding confidence and perception of milk supply (4-point Likert scale); breastfeeding duration intention; and satisfaction with the Thompson method.

2.5.2.3. Survey at 3-months after birth. Women who completed the discharge survey were invited to complete a 3-month survey via email invitation using a link to the Qualtrics survey between May and November 2019. Following the initial email survey invitation, non-responders were followed-up with a phone call 1-week after email invitation. If agreeable, the woman then completed the survey via telephone. If uncontactable, the woman was considered lost-to-follow up. The survey collected data on baby's age (weeks); type of feeding in the last 24 h (Forster et al., 2019); breastfeeding problems; breastfeeding duration intention; reasons for breastfeeding cessation; and satisfaction with the Thompson method. Type of feeding in the last 24 h was coded in accordance with WHO definitions:

- exclusive breastfeeding infants receiving only breast milk (including expressed breast milk) with no other liquids or solids except for drops or syrups consisting of medicines, vitamins and minerals (World Health Organization, 2008)
- partial breastfeeding the infant is receiving some breastfeeds but also other food-based fluids, such as artificial baby milk or weaning foods (World Health Organization, 2008)
- artificial feeding infants is only receiving milk (other than breastmilk) whether or not it is suitable for that purpose (e.g., artificial formula, cows' milk) (World Health Organization, 2008)

Only participants who completed both surveys were included in the final data set. Therefore, there was no analysis of respondents who were lost to follow up. A breastfeeding study was conducted by the study authors in the same setting in 2011–2012, using infant feeding surveys administered at hospital discharge, 3-months, and 6-months (O'Connor et al. 2017). The dataset from this study were refined (i.e., privately insured women excluded) and used as comparator data for the *primary outcome exclusive breastfeeding at 3-months.*

2.6. Statistical analysis

2.6.1. Interrupted time series analysis

Routinely collected data were entered in real-time, with outcomes recorded at monthly intervals during the 24-month baseline period (January 2016 – Dec 2017). Implementation commenced in January 2018 (when the online learning package became available) and ceased in March 2018 (when 80% of midwives had completed the learning package); data were excluded during the implementation period. Routinely collected data were recorded at monthly intervals during the 15-month post-implementation period (Apr 2018 – June 2019). We conducted a descriptive and bivariate comparison of the characteristics of the mothers and babies in the baseline group and post-implementation group. We performed analysis with Stata's 'itsa' command to analyse the time series data using a segmented linear regression model to assess the immediate impact and monthly change in trend of key rates pre and post implementation. Specifically, we used the Newey-West segmented regression model. After perusing our model fit to the data, we assumed a linear relationship between time and the outcome within each segment (pre- and post-intervention). Autocorrelation among the model errors was assessed using a plot of the partial autocorrelation function, and we found that autocorrelation among errors for up to two lags, correspondingly a Newey-West segmented regression with two lags provided the best fit to our data, while satisfying the model assumptions.

There is no agreed method for determining adequate sample size for ITS studies but a sufficient number of time points before and after the intervention are needed to conduct a segmented regression analysis. A systematic review concluded that at least 10 pre- and 10 post-intervention time points are required to have ≥80% power to detect a change in level of five standard deviations of the pre-data if the autocorrelation is >0.4 (Ramsay et al., 2003). Additionally a long pre-intervention phase increases power to detect secular trends which reduces the risk of a Type 1 error (Ramsay et al., 2003). We gauged the sufficiency of our analyses' power based on effect sizes, the width of their confidence intervals, and ultimately, their statistical significance. $P < 0.05$ was considered statistically significant. All analysis was performed in Stata 16.0.

2.6.2. Survey analysis

The number and percentages presented for categorical variables and median and interquartile range was presented for non-normally distributed continuous variables. Non-normally distributed variables were analysed with Wilcoxon rank-sum and categorical variables were analysed with chi-square test. The significance level was set as <0.05. A multi-level logistic regression was conducted to compare the rate of change in exclusive breastfeeding between hospital discharge and 3-months postpartum for the baseline group and the Thompson group, after adjusting for demographic and clinical confounders. All analysis was performed in Stata 16.0.

2.7. Ethics statement

The study received institutional ethical approval prior to commencement (HREC/16/MHS/77). The implementation and ITSA components of the study met the National Health and Medical Research Council's requirements for waiver of participants' consent. This was because it was impracticable to obtain consent given the hospital-wide change and involvement in the study carried negligible/low risk. There is no known or likely reason for thinking that participants would not have consented if they had been asked. Participants were made aware of the research through posters displayed in public clinic and public postnatal ward areas. In addition, flyers about the project were distributes to women in the aforementioned areas and in childbirth preparation classes. The posters/flyers told women that they were able to opt out and informed them how they could do that. Mother-baby data were de-identified prior to release to the research team for analysis. Participants were recruited for the survey component of the study following written informed consent processes.

3. Results

Results are presented in two sections: ITSA results and survey results.

3.1. Interrupted time series analysis

Fig. 1 reports the number of participants included and excluded (including reasons for exclusion) in the ITSA across baseline, implementation, and post-implementation periods. There were several statistically significant differences in demographic and clinical characteristics, which are in bold in Table 2. It is important to note that clinically significant differences were lower rates of tertiary education and higher rates of caesarean birth in the post-implementation group; both variables are independently associated with not breastfeeding.

3.1.1. Breastfeeding trends at hospital discharge

Pre-implementation, there were significant declining monthly trends in direct breastfeeding (0.36%, 95% CI: −0.51% to −0.21%; $p < 0.001$), and exclusive breastfeeding (0.43%, 95% CI: −0.54% to −0.31%; $p < 0.001$). In the 2 years prior to implementation, the exclusive breastfeeding rate decreased 10 percentage points from 85% to 75%. Fig. 2 presents significant changes in direct breastfeeding trends at hospital discharge pre and post implementation of the Thompson method.

Post-implementation, the declining trend in direct breastfeeding was significantly averted by 0.39% each month (95% CI: 0.03% to 0.76%; $p = 0.037$) relative to baseline. Similarly, the declining trend in exclusive breastfeeding was significantly averted by 0.42% each month (95% CI: 0.20% to 0.63%; $p < 0.001$) relative to baseline (see Supplementary material Fig. 2). Changes to partial breastfeeding and artificial feeding were non-significant (see Supplementary material Figs. 2 & 3).

3.1.2. Nipple damage and poor attachment at hospital discharge

Pre-implementation, the trends in proportion of women with documented nipple damage or poor attachment, were not significantly changing. For nipple damage, there was a non-significant monthly decrease (0.05%, 95% CI: −0.10% to 0.01%; $p = 0.109$). For poor attachment, there was a non-significant monthly increase (0.07%, 95% CI: −0.01% to 0.16%; $p = 0.093$). Post-implementation, there was a 0.07% increasing monthly trend (95% CI: 0.04% to 0.10%; $p < 0.001$) in midwife-report nipple damage (see Supplementary material Fig. 4). There was no significant difference in the monthly trend for poor attachment despite decreasing by 0.06% (95% CI: −0.25% to 0.12%; $p = 0.488$) relative to baseline (see Supplementary material Fig. 5).

3.2. Surveys

Only participants who completed both discharge and 3-months survey (n = 331) were included in post-implementation survey results. Baseline group survey data were derived from 164 participants who were publicly insured, gave birth in the research setting, and completed a 3-month survey in 2011–2012 (O'Connor et al., 2017). There were several significant differences in demographic and clinical characteristics of survey participants (see Supplementary material Table 1).

Demographically the Thompson group were more likely to be partnered: 87.6% (n = 290) versus 79.9% (n = 131, $p = 0.023$); and to have an education ≥ Year 12: 93.6% (n = 308) versus 86.0% (n = 141, $p = 0.005$). Clinically significant differences associated with negative breastfeeding outcomes were more prevalent in the Thompson group including lower rates of spontaneous onset of labour (47.4%, n = 157) versus (61.0%, n = 100, $p = 0.005$); higher rates of oxytocin use in labour (44.1%, n = 146) versus (35.4%, n = 58, $p = 0.063$) and higher use of epidural analgesia (46.8%, n = 155) versus (31.1%, n = 51, $p < 0.001$). Conversely, women in the Thompson group were significantly more likely to have 60 min or more of skin-to-skin contact at birth: 54.7% (n = 181)

Table 2
Demographic and clinical characteristics of participants (n = 13,667).

Variables	Pre-implementation Jan 2016 – Dec 2017 n = 8350	Post-implementation Apr 2018 – June 2019 n = 5317	*p*-Value
Maternal age, mean (SD)	**30.7 (5.1) (n = 8350)**	**31.1 (5.2) (n = 5317)**	**<0.001**
Body Mass Index, median (IQR)	**23.0 (20.5, 26.8) (n = 8345)**	**23.4 (20.8, 27.5) (n = 5303)**	**<0.001**
Ethnicity			**<0.001**
Caucasian/European	3811 (45.6%)	2299 (43.2%)	
Asian	2447 (29.3%)	1449 (27.3%)	
Indigenous Australian	232 (2.8%)	137 (2.6%)	
Other	1860 (22.3%)	1431 (26.9%)	
Education			**<0.001**
<Grade 10	258 (3.2%)	191 (3.7%)	
Grade 10–12	2543 (31.2%)	1942 (37.5%)	
Tertiary	5360 (65.7%)	3046 (58.8%)	
Marriage status			**<0.001**
Married or de facto	6977 (83.7%)	4645 (87.9%)	
Not married or de facto	1359 (16.3%)	641 (12.1%)	
Parity			0.65
Multiparity	4540 (54.4%)	2909 (54.8%)	
Nulliparity	3809 (45.6%)	2402 (45.2%)	
Socioeconomic status (SEIFA)			0.10
Quintile 1 (most disadvantaged)	1067 (12.8%)	666 (12.5%)	
Quintile 2	540 (6.5%)	393 (7.4%)	
Quintile 3	1245 (14.9%)	819 (15.4%)	
Quintile 4	2494 (29.9%)	1504 (28.3%)	
Quintile 5 (most advantaged)	2998 (35.9%)	1933 (36.4%)	
Smoking status at booking			0.41
Non-smoker	7894 (94.7%)	5006 (94.4%)	
Smoker	441 (5.3%)	298 (5.6%)	
Previous caesarean section	1304 (15.6%)	896 (16.9%)	0.055
Pregnancy complications - gestational diabetes	972 (11.6%)	674 (12.7%)	0.070
Induction of labour	2963 (35.5%)	1976 (37.2%)	0.045
Narcotic analgesia in labour	981 (11.7%)	485 (9.1%)	<0.001
Regional analgesia in labour	3459 (41.4%)	2455 (46.2%)	<0.001
Caesarean birth	2210 (26.5%)	1595 (30.0%)	<0.001

Interquartile range (IQR), probability value (*p*-value), standard deviation (SD).

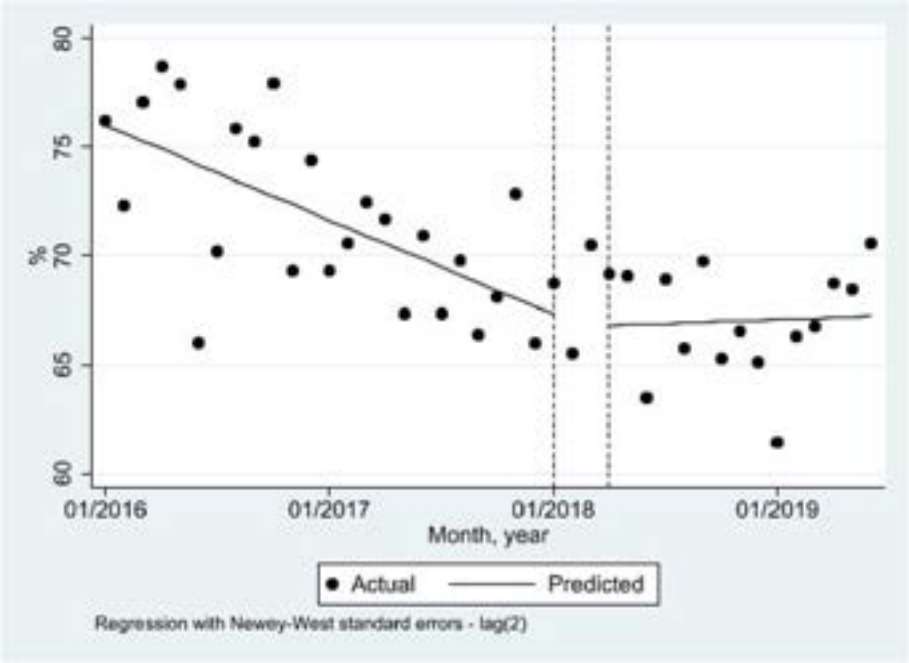

Fig. 2. Direct breastfeeding trends at hospital discharge.

versus 25.6% (n = 42, $p < 0.001$), which predicts breastfeeding exclusivity and duration.

3.2.1. Breastfeeding outcomes at 3-months

Women in the Thompson group (n = 331) were surveyed at a median of 14 weeks postnatally (IQR 13–15 weeks) compared to the baseline group (n = 164) median postnatal age of 13 weeks (IQR 13–15 weeks, p < 0.001). Women were surveyed about how they breastfed their babies in the past 24 h. The rate of any breastfeeding in the past 24 h was higher in the Thompson group: 81.3% (n = 269) versus 76.8% (n = 126, $p = 0.25$) compared to baseline group, but not statistically significant. The exclusive breastfeeding rate in the Thompson group: 57.4% (n = 189) versus 54.3% (n = 89, $p = 0.50$) was higher than baseline; however, the sample size was small, and this result did not reach statistical significance. The partial breastfeeding rate in the Thompson group was significantly higher: 21.0% (n = 69) versus 11.0% (n = 18, p = 0.006) and the artificial feeding rate was lower: 18.2% (n = 60) versus 23.2% (n = 38, $p = 0.20$). Combined these results indicate a trend

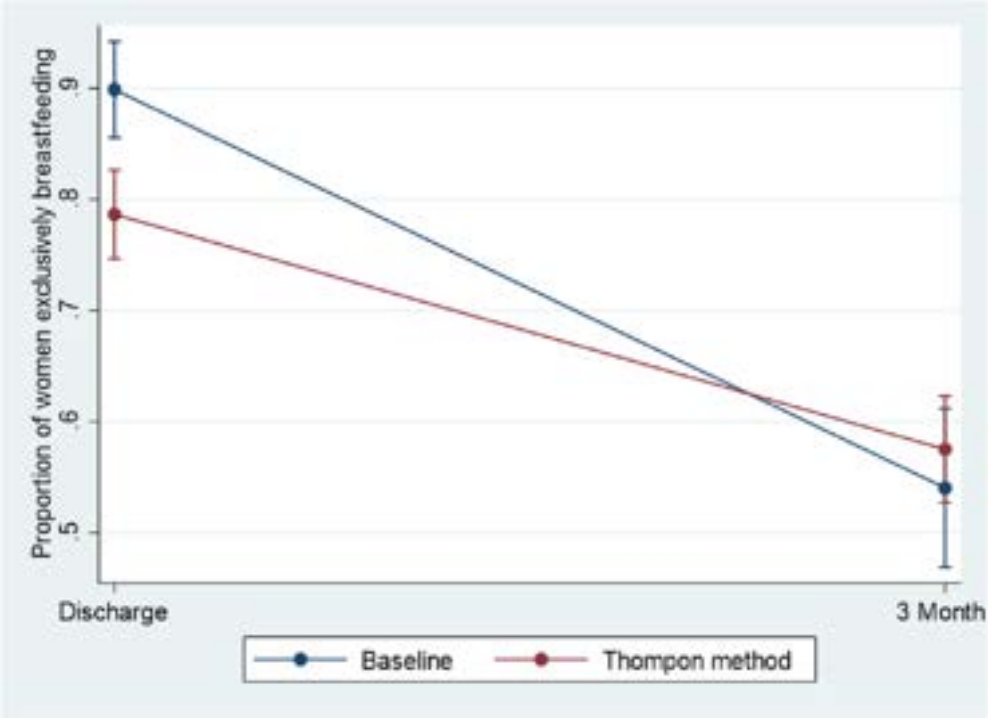

Fig. 3. Change in proportion of women exclusively breastfeeding over time.

toward higher rates of any breastfeeding, exclusive breastfeeding, and a trend away from artificial feeding at 3-months postpartum.

A multi-level logistic regression was conducted to compare the rate of change in exclusive breastfeeding between hospital discharge and 3-months postpartum for the baseline group and the Thompson group, after adjusting for demographic and clinical confounders listed in Supplementary material Table 1. The overall model demonstrated a significant interaction in breastfeeding between the treatment effect and time, suggesting that the rate at which women stop exclusively breastfeeding differed between the baseline and Thompson group. A subsequent subgroup analysis revealed the relative odds of continuing to exclusively breastfeed (retention) in the Thompson group was 0.25 (95% CI: 0.17 to 0.38; $p < 0.001$), significantly better than the baseline group ($Z = 3.23$, $p < 0.01$) where the relative odds of continuing to exclusively breastfeed was only 0.07 (95% CI: 0.03 to 0.19; $p < 0.001$). This retention in the Thompson group is clear in Fig. 3, where the attrition in exclusive breastfeeding was considerably higher in the baseline group (sharper negative slope) compared to the Thompson group. Using the proportions of breastfeeding at each time-group in Fig. 3 we can calculate relative risks of still exclusively breastfeeding at 3 months. The relative risk of attrition in the baseline group was 0.61 (i.e., only 61% of mothers breastfeeding at discharge were still exclusively breastfeeding at 3-months) compared to a significantly higher rate of exclusive breastfeeding retention in the Thompson group (74% of mother breastfeeding at discharge were still exclusively breast feeding after three months).

Table 3
Discharge survey results (n = 331).

	n (%)
Since this time yesterday have you used the Thompson method?	200 (60.4%)
Components used mostly or always to breastfeed at hospital discharge	
1. Position and hold (i.e., cradle)	199 (60.1%)
2. Breast-shaping (i.e., none)	150 (45.5%)
3. Nipple alignment (mouth to nipple)	271 (82.1%)
4. Connection and seal (all four points)	250 (76.0%)
5. Adjustment (fine tuning)	195 (59.1%)
6. Timing (both breast – rest and digest)	307 (92.8%)
Midwives in the postnatal ward always or mostly did the following	
Put the baby on the breast for me	52 (15.8%)
Offered "hands off" help when I needed it	196 (59.4%)
Helped me to work out my baby's feeding behaviour	101 (30.6%)
Helped me feel self-confident	202 (61.4%)
Gave consistent advice/education	182 (55.5%)
If you had another baby, would you use the Thompson breastfeeding method?	
Yes	253 (76.9%)
No	14 (4.3%)
Not sure	62 (18.8%)
Which of these statements is closest to how you feel at present?	
Breastfeeding is difficult now, but I think/hope it will get easier	117 (35.5%)
I am not feeling confident about my ability to breastfeed my baby	6 (1.8%)
I feel confident about my ability to breastfeed my baby	207 (62.7%)
How would you describe your volume of breast milk at the moment (or colostrum)?	
Just the right amount	212 (64.2%)
Not enough	43 (13.0%)
Not sure	69 (20.9%)
Too much	6 (1.8%)
Has your baby had any expressed breastmilk in hospital?	139 (41.5%)
Reason for EBM supplementation in hospital	
Feeding issues	91 (65.5)
Midwife's advice	78 (56.1)
Not sure or other	65 (46.8)
Low blood sugar levels	25 (18.0)
My request	22 (15.8)
Jaundice	3 (2.2)
Doctor's advice	2 (1.4)
Has your baby had any infant formula in hospital?	89 (26.6)
Reason for infant formula supplementation in hospital	
Not sure or other	48 (54.0)
Feeding issues	40 (45.0)
Midwife's advice	34 (38.0)
My request	33 (37.0)
Low blood sugar levels	19 (21.0)
Doctor's advice	8 (9.0)
Jaundice	6 (7.0)

3.2.2. Implementation results

A measure of implementation success was the proportion of women surveyed who had knowledge of the Thompson breastfeeding method. At hospital discharge, only two-thirds of women surveyed recalled getting information about the Thompson method, and a third reported they were completely unfamiliar with it (Table 3). Women were surveyed about which components of the Thompson method they used, and how they perceived midwifery breastfeeding support (Table 3). More than 75% of women used the baby-led components of alignment, connection, and seal; but fewer than 50% avoided breast shaping. Postnatal midwives predominantly offered hands-off assistance. Level of satisfaction with the Thompson method was high, with most women surveyed indicating they would use the Thompson method for their next baby (Table 3).

3.2.3. Breastfeeding outcomes at hospital discharge

Following Thompson implementation, most survey participants discharged hospital feeling confident about their ability to breastfeed and perceived they had adequate milk supply (Table 3).

4. Discussion

When selected interventions are well-implemented, breastfeeding rates are responsive and can improve quickly (Rollins et al., 2016). We hypothesised that implementation of the Thompson method would lead to an increase in breastfeeding rates at hospital discharge and 3-months postpartum. Implementation of the Thompson method for well mother-baby pairs improved direct breastfeeding trends at hospital discharge and reduced the risk of exclusive breastfeeding discontinuation by 3-months for women who discharged hospital exclusively breastfeeding. The positive impact of the method was potentially confounded by partial implementation and a parallel rise in birth interventions which undermine breastfeeding. Therefore, while the Thompson method appears beneficial in terms of breastfeeding exclusivity and duration, further research is warranted.

4.1. Birth interventions

The positive impact of the Thompson method on breastfeeding at hospital discharge occurred despite the significantly higher rates of birth intervention that acted as co-variates. These interventions included significantly higher rates of induction and augmentation of labour, epidural analgesia, and caesarean section. An Australian study of over 490,000 women and their children demonstrated that women who experienced any of the aforementioned birth interventions were at increased risk of breastfeeding problems in the first 28 days, including poor feeding and failure to thrive (Peters et al., 2018). In a study of close to 100,000 women, induction of labour was associated with delayed initiation of breastfeeding (Guerra et al., 2009). However, systematic review drawing on data from two trials (n = 7487) concludes that induction of labour is unlikely to have an effect on breastfeeding at hospital discharge (Middleton et al., 2020). In a recent systematic review of 23 studies on the effects of epidural analgesia, most studies (n = 12) report negative breastfeeding effects, followed by no effects (n = 10), and positive effects (n = 1) (French et al., 2016). A systematic review of 53 studies (n = 554,568) from 33 countries reports women who had a caesarean birth (either planned or unplanned), compared to vaginal birth (either spontaneous or instrumental), have a lower odds of exclusive breastfeeding (19% less likely), and any breastfeeding (14% less likely) at 6-months (Prior et al., 2012). In summary, rising rates of birth intervention in this setting confounded our results. Future research designs

should account for this through use of a concurrent control group, using clustered randomised trial design.

4.2. Breastfeeding duration

All types of additional, organised breastfeeding support, whether professional or lay, increase breastfeeding duration in terms of exclusive breastfeeding and any breastfeeding at 6-weeks and 6-months (McFadden et al., 2017). In the context of declining breastfeeding rates, women in the survey control group (2011–2012) had a higher rate of exclusive breastfeeding at hospital discharge, compared to women in the Thompson group. Analysis of only women who discharged exclusively breastfeeding, demonstrated that women in the Thompson group were more likely to continue exclusive breastfeeding at 3-months, compared to those in the control group.

4.3. Nipple damage

Surprisingly, we measured a small rising monthly trend in midwife-reported nipple damage (0.07%), with no change in attachment difficulties. While the nipple trauma result was statistically significant, it is arguable not clinically significant. Given there is no consensus definition of nipple trauma, and individuals assess identical scenarios differently, this finding should be interpreted with caution (Nakamura and Asaka, 2022). Future research should use a reliable and validated observational tool, like the recently developed *Seven signs of nipple trauma associated with breastfeeding* (Nakamura and Asaka, 2022).

4.4. Partial implementation

Discharge survey results demonstrate that despite high-level organisational buy-in, tailoring of the innovation for simplicity and relative advantage, and having a plan to assess, document and feedback on progress; only partial implementation was achieved. One third of surveyed women were completely unfamiliar with the method, and there was a wide variety in which components of the Thompson method were consistently used. Implementation in maternity care is helped or hindered by organisational, personal, and contextual factors (Dadich et al., 2021). In this setting, lactation consultants were early adopters and champions for Thompson method, but midwives in general challenged the change to breastfeeding practice and some made the decision not to adopt it. There was significant delay between initial information about the Thompson method and train-the-trainer sessions (January – April 2017) and availability of the learning package for midwives to complete 9-months later. Furthermore, staff attrition and use of agency or casual staff (who were not required to undertake the learning package) will have impacted the proportion of midwives who had the knowledge and skills to use the method. The challenges with implementation were consistent with those experienced by Baby Friendly Hospital Initiative including mixed levels of support, funding constraints, high turnover of staff, lack of internal monitoring system (World Health Organization, 2017b). Future implementation studies need to be better resourced; and include strategies to address midwives' concerns and capitalise on their interest during the pre-adoption stage and early use stages (Greenhalgh et al., 2004).

Future implementation studies should consider co-design and tailoring to meet the needs of specific groups who are at highest risk of not breastfeeding (Segura-Pérez et al., 2021). In the Australian setting, women who are less likely to start or continue breastfeeding are those most affected by the social determinants of health, for example, young mothers. Research suggests providing in-home breastfeeding support is critical to improving breastfeeding rates for vulnerable women (Francis et al., 2020). Future research should consider focussing on not only postnatal ward midwives, but specifically training midwives who provide in-home breastfeeding support. In this study, postnatal homecare midwives did not receive specialised support although they were invited to all educational activities.

4.5. Limitations

4.5.1. Interrupted time series analysis

We used a single population group which aimed to limit the selection bias and confounding due to between-group differences and were surprised at how the groups changed over time. In this setting, using a control group (privately insured patients) who were simultaneously *not exposed* to the Thompson method was not feasible. This is because there are significant differences demographic and clinical differences in the characteristics of public and private patients; and potential threats to fidelity through contamination of staff trained in the method working in both public and private areas. We recommend future research consider using a cluster randomised trial design, including multiple hospital sites, to ensure balance of observable and non-observable factors between groups. In the study, we measured a doubling in the rate of skin-to-skin contact for at least 60 min following implementation of the Thompson method. This is a potential confounder because skin-to-skin contact for 60 min independently predicts any breastfeeding at 1–4 months after birth (Moore et al., 2016).

4.5.2. Survey

The main limitation of the survey was that baseline survey results derived from secondary analysis of data collected in 2011–2012. Breastfeeding rates declined dramatically between 2011 and 2019. While this was averted by introduction of the Thompson method in 2018, the rates of exclusive breastfeeding at hospital discharge remained lower in 2019 than 2011. Therefore, a higher proportion of women in the baseline group discharged hospital exclusively breastfeeding. While the Thompson group had a higher rate of exclusive breastfeeding at 3-months, which was clinically significant, it was not statistically significant. Additionally, survey participants who completed the discharge survey but were lost to follow-up at 3-months were excluded from analysis. Analysis of the differences between women who completed the 3-month survey versus those lost to follow-up may have been useful.

5. Conclusions

Following implementation of a breastfeeding intervention, we observed a small but significant benefit for well mother-baby pairs, with rising direct breastfeeding and exclusive breastfeeding trends at hospital discharge, compared to monthly trends recorded 24-months prior to the intervention. To control for co-interventions and changes in participant characteristics over time, we recommend future research use a cluster randomised trial design.

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CRediT authorship contribution statement

Jyai Allen: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Yu Gao:** Data curation, Formal analysis, Visualization, Writing – review & editing. **Julie Germain:** Investigation, Resources, Writing – review & editing. **Michelle O'Connor:** Methodology, Resources, Writing – review & editing. **Cameron Hurst:** Formal analysis, Writing – review & editing. **Sue Kildea:** Conceptualization, Methodology, Writing – review & editing, Project administration, Funding acquisition.

Data availability

The statistical analysis plan will be made available for research purposes upon request to the corresponding author. The availability of

deidentified data supporting the conclusions of this article is subject to approval of study authors and Mater Research Ethics and Governance Committees.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnurstu.2023.104474.

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