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# Stable Trends in Clinical Outcomes Before Introduction of Couplet Care in a Danish Neonatal Intensive Care Unit

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## ABSTRACT

**Aim:** Prior to the implementation of couplet care in 2025, knowledge of clinical outcomes was central to support feasibility and future evaluation. We aimed to review trends on mode of delivery, duration of respiratory support, nutrition at discharge and weight gain.

**Methods:** This was a descriptive register-based study that used data from a local database, Neobase. The database consisted of prospectively collected data on all infants admitted and discharged from a neonatal intensive care unit in the Capital Region of Denmark. Demographic and clinical data in the period of 2018–2024 were retrieved and analysed.

**Results:** We included 4969 infants with a mean gestational age of 37, 6 weeks and a mean birth weight of 2926 g. Vaginal birth was the most frequent mode of delivery. However, a slight upward trend in Caesarean section was observed. The majority of infants were discharged on their mothers' milk. The median duration of respiratory support remained stable at 1 day, and the median weight gain remained zero throughout the study period.

**Conclusion:** Key outcomes considered sensitive to couplet care remained stable over the seven-year period. These findings establish an essential reference for the prospective evaluation of couplet care, as well as its feasibility in practice.

## 1 | Introduction

Worldwide, 10% of all infants require admission to a neonatal intensive care unit (NICU) after birth. This is most commonly due to preterm birth or birth-related illness, with respiratory distress being the leading cause of admission [1, 2]. In Denmark, 11% of infants are admitted to a NICU within the first day of life, a proportion which has remained stable nationwide [3]. Preterm infants below 35 weeks of gestational age (GA) are most often cared for in NICUs, whereas infants above 35 weeks of GA are usually taken care of in maternity units, unless they have medical problems or birth-related illness. Infants can be admitted directly from the delivery ward, the maternity unit, from home, or transferred from other hospitals. NICU admission disrupts early biological processes and places families in a highly stressful and vulnerable environment [4]. In recent decades, neonatal care has shifted towards models that emphasise parental presence and skin-to-skin contact (SSC), including family centred care, single-family rooms, and involving parents as primary caregivers [5, 6]. To improve neonatal care and meet families' needs, the concepts of zero separation and couplet care have gained global

**Abbreviations:** C-section, Caesarean section; GA, gestational age; IQR, interquartile range; NICU, neonatal intensive care unit; SSC, skin-to-skin contact.

**Summary**

- Prior to the implementation of couplet care in 2025, knowledge of core clinical outcomes among admitted infants was central to supporting feasibility and future evaluation.
- Trends suggested a stable pre-implementation setting, with general stability in mode of delivery, nutritional status at discharge, duration of respiratory support and weight gain.
- The findings may serve as an essential reference for the prospective evaluation of couplet care as well as its feasibility in practice.

attention in the past 10 years [7–9]. These concepts are defined as keeping mother and infant together even when specialised neonatal care is required [6–8]. Several factors influence the practice of couplet care and early SSC, for example, the organisation of postnatal care, unit design and delivery mode [10]. Infants born via Caesarean section (C-section) have a higher NICU admission rate and lower odds of early SSC compared with vaginal deliveries [8, 11]. Couplet care has the potential to minimise maternal–infant separation and facilitate early SSC, thereby supporting both physiological and emotional outcomes for infants and families [12]. While evidence suggests that couplet care may improve clinical outcomes, including breastfeeding, growth and respiratory support, findings remain variable or inconsistently reported [13–15]. For example, some studies have reported improved breastfeeding outcomes, whereas others find little or no differences [15, 16]. We are only aware of one study which has examined infant weight gain, and it found no differences at discharge [17]. Regarding respiratory support, no studies to date have specifically examined respiratory status during couplet care, despite the well-established association between SSC and improved respiratory status. This suggests that couplet care may also positively influence respiratory outcomes [18].

In 2025, our hospital began implementing couplet care, highlighting the need to assess baseline data on infant outcomes before full implementation of the model. Assessing historical trends provides critical insights into the existing clinical context and variation in practice. These trends can inform implementation planning and establish a baseline for prospective evaluation after the introduction of new care models. This study aimed to review trends in selected clinical outcomes shown to be sensitive to couplet care among infants admitted to a Danish NICU during the period of 2018–2024.

## 2 | Methods

### 2.1 | Design and Setting

This study was a descriptive register study based on data from a Danish NICU in the period of 2018–2024. The NICU from which data were retrieved is considered a mixed level 2–3 NICU [19] and receives premature and ill infants from 28 weeks of GA. The care philosophy in the unit over the seven-year period relied on the principles of family centred care [20], with a rooming-in practice and a 24-h a day visiting policy in shared family rooms. In November 2025, the unit was reorganised with new facilities, single-family rooms and couplet care. Prior to this, routine practice included separating the mother and infant after birth and admitting them to separate units with separate care responsibilities.

### 2.2 | Description of the Neobase and Data Collection

The Neobase register was established in 1996 as a database for research and quality assurance of the treatment of premature and ill infants. Several studies have been based on data from the Neobase [21, 22]. The national Neobase closed in 2017 but has remained active locally since then. Data from the Neobase were prospectively recorded on standardised sheets with clinical and demographic information on all admitted infants. The data were collected from medical records by physicians and manually entered into an Excel file (Microsoft Corp, Washington, USA) by a secretary. To ensure data validity, a physician reviewed all medical records with missing data and entry errors. Variables with more than 20 missing or incorrect entries underwent additional random validation across the study period. Missing data were mainly attributable to the transition to a new electronic medical record system in 2016–2017 as well as documentation gaps. Andersson et al. [21] reported high validity of Neobase respiratory variables with a positive predicted value of 87%–100% compared with bedside nursing documentation. This is likely attributable to other Neobase outcomes as well.

Clinical data were extracted from the local Neobase in March 2025. The data included the following demographic and clinical variables: admission year, GA, Apgar score, birth and discharge weight, admission diagnosis, admission course, antibiotic treatment, mode of delivery, type of birth, respiratory support, nutrition at discharge. Weight gain during admission was calculated as the difference between birth weight and discharge weight and thus computed to a median weight gain. For this study, data were retrieved on all inborn or transferred infants, as infants admitted from home were excluded due to limited data validation. To ensure a complete dataset, data from complete calendar years from 2018 to 2024 prior to the implementation of couplet care in 2025 were included.

### 2.3 | Statistics

Descriptive statistics were used to summarise proportion and trends. Data were organised according to the year of admission. All statistical analyses were performed using STATA 2019 (Stata Corp, TX, USA).

### 2.4 | Ethics

The study did not involve any contact with patients or access to patient files, and informed consent and ethical approval were not required. The study was registered in Privacy, which is the

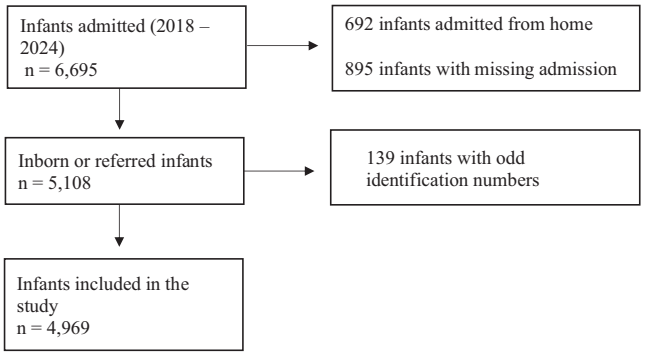


**FIGURE 1** | Flowchart of study sample.

Capital Region of Denmark's research registry (p-2025-19815). All the data were anonymised with an identification number and stored on a password protected drive.

## 3 | Results

During the study period, 6695 infants were admitted to the NICU, and 1726 were excluded due to admission from home, missing data, and odd identification number. This means that 4969 infants were included in the study (Figure 1).

The infants' mean GA and birth weight were 37.6 ± 3.65 weeks and 2926 ± 913.20 g, respectively. The three most common diagnoses categories for admitted infants were maturity, including weight and GA (28.9%), lung and circulatory diseases (17.7%), and cerebral complications (7.1%). During the seven-year period, 88.6% of infants were inborn (mean = 628 ± 79.40) and an average of 81 ± 21.40 infants were transferred annually from outside hospitals (Table 1).

### 3.1 | Delivery Mode

Vaginal birth was the most frequent mode of delivery, with a slight downward trend in the last quarters of 2024 (Figure 2). On average, there were 386 ± 51.29 vaginal births annually. During this period, acute C-section accounted for 32.4% of deliveries (Table S1). The acute C-section rate stayed relatively stable; however, with a slight upward trend from 2018 to 2024 (Figure 2). Assisted vaginal and elective C-section remained rare and stable over the study period.

### 3.2 | Nutrition at Discharge

During the seven-year period, mothers' milk, administered via breastfeeding or bottle feeding, accounted for most of the nutrition at discharge, with only minor quarter-to-quarter variation (Figure 3). Overall, 79.0% of discharged infants received exclusive mothers' milk, 11.6% received a mix of mothers' milk and formula, and 4.3% just received formula (Table S2). The proportion of infants discharged on formula remained relatively stable, while mixed feeding showed occasional increases. This indicated that most infants received at least some of their mothers' milk at discharge. Non-oral and other feeding types were rare throughout (Figure 3).

**TABLE 1** | Characteristic of the study population.

| Characteristics | Total (%) | Mean (standard deviation) |
|---|---|---|
| Gestational age | | 37.6 (3.65) |
| < 28 | 104 (2.09) | |
| 28–31 | 286 (5.76) | |
| 32–36 | 1397 (28.11) | |
| 37–41 | 2315 (46.59) | |
| > 41 | 811 (16.32) | |
| Missing | 56 (1.13) | |
| Birth weight | | 2926 (913.20) |
| < = 1000 g | 112 (2.3) | |
| 1001–1500 g | 249 (5.2) | |
| 1501–2500 g | 1303 (26.2) | |
| 2501–4500 g | 3115 (62.7) | |
| > 4500 g | 94 (1.9) | |
| Missing | 86 (1.7) | |
| Apgar score 5 min | | 9 (1.47) |
| 0–3 | 73 (1.5) | |
| 4–6 | 197 (4.0) | |
| 7–10 | 4515 (90.9) | |
| Missing | 184 (3.7) | |
| No. of liveborn | | |
| Singleton | 4267 (85.9) | |
| Twins | 564 (11.4) | |
| Triplets | 15 (0.3) | |
| Missing | 123 (2.5) | |
| Admission course | | |
| Inborn | 4402 (88.6) | |
| Referred from level III NICU | 472 (9.5) | |
| Referred from level I-II NICU | 95 (1.9) | |
| Antibiotic treatment | | |
| None | 3847 (77.4) | |
| Prophylactic treatment | 257 (5.2) | |
| Clinic infection | 799 (16.1) | |
| Positive blood culture | 50 (1.0) | |
| Missing | 16 (0.3) | |
| Admission diagnosis (primary) | | |

(Continues)

**TABLE 1** | (Continued)

| Characteristics | Total (%) | Mean (standard deviation) |
|---|---|---|
| Blood diseases | 164 (3.3) | |
| Cerebral complications | 352 (7.1) | |
| Gastrointestinal diseases | 13 (0.3) | |
| Hormone and metabolic diseases | 52 (1.1) | |
| Infection | 137 (2.8) | |
| Lung and circulatory diseases | 878 (17.7) | |
| Malformations | 142 (2.9) | |
| Weight, GA, or maturity | 1438 (28.9) | |
| Missing | 1793 (36.1) | |

Abbreviation: NICU, neonatal intensive care unit.

### 3.3 | Duration of Respiratory Support

Over the seven–year period, 2467 infants (49.9%) received respiratory support. Treatment duration ranged from 1 to 92 days but was typically short. Median duration remained stable at one day with an interquartile range (IQR) of one to three or four days annually. This indicated that while approximately half of the admitted infants required respiratory support, treatment was brief for the majority (Table S3). Duration varied by GA. Infants who were below 28 weeks of GA and 28–31 weeks of GA had the longest courses with a median of 32 and 11 days, respectively. Infants above 32 weeks generally required less than two days of respiratory support. No consistent upward or downward trend was evident, although yearly variation was observed in infants born below 32 weeks (Figure 4).

### 3.4 | Weight Gain During Admission

Median weight gain remained zero throughout the study period, indicating overall stable growth outcomes over time (Figure 5). Only two quarters deviated from this pattern, showing modest negative median values of approximately −10 and −11. The IQR was wide across all years, reflecting substantial variability in individual weight changes. It appears to be driven by isolated extreme observations, with occasional measurements showing both marked weight loss and gain (Figure 5).

## 4 | Discussion

In this register-based study of nearly 5000 infants admitted to a level 2–3 NICU, we observed general stability in several key clinical outcomes that are considered sensitive to couplet care. These included mode of delivery, nutritional status at discharge, duration of respiratory support, and weight gain during admission. Despite year-to-year variations, no consistent temporal trends were noticeable across the study period. Importantly, the noted stability occurred in a setting with relatively high rates of vaginal delivery, short durations of respiratory support for most infants, and a consistently high proportion of infants discharged on mother's milk. This suggests that the unit already operated within a supportive care context, which may affect both the feasibility and the measurable impact of introducing couplet care.

The predominance of vaginal deliveries indicates a population in which couplet care is feasible, as mode of delivery can influence the timing of SSC and initiation of couplet care in the NICU [23]. The relatively high proportion of acute C-sections in this study and the slight upward trend highlight a potential barrier to immediate couplet care initiation. However, new care models and equipment have been developed in many NICUs, and these allow immediate SSC despite acute C-section [24]. The upward trend aligned with reports from other high-income settings, which described gradual increases in C-section rates [25]. According to the World Health

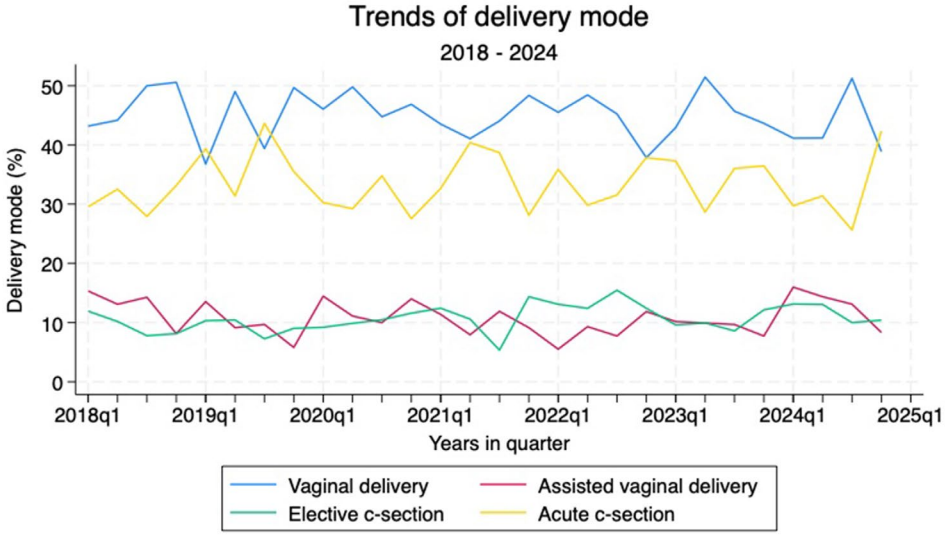


**FIGURE 2** | Quarterly trends of delivery mode between 2018 and 2024.

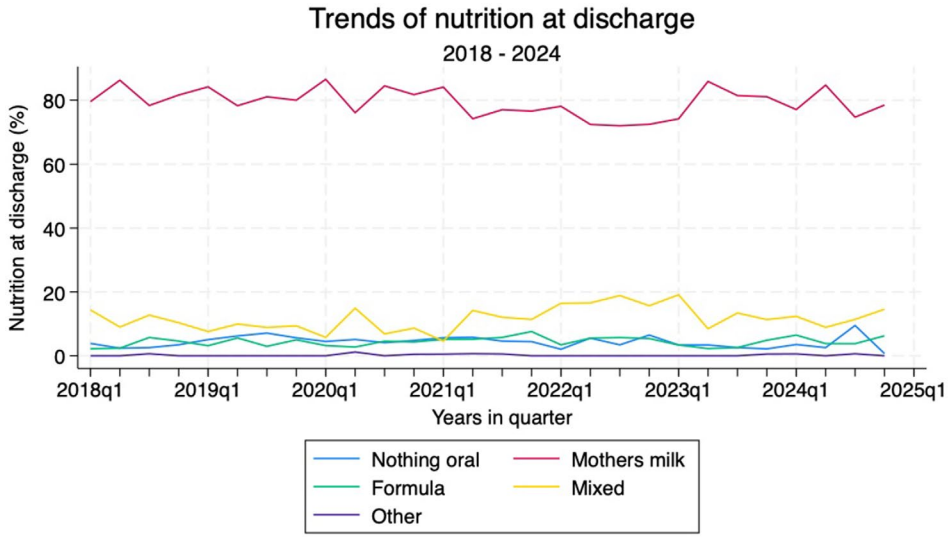


**FIGURE 3** | Quarterly trends of nutrition at discharge between 2018 and 2024.

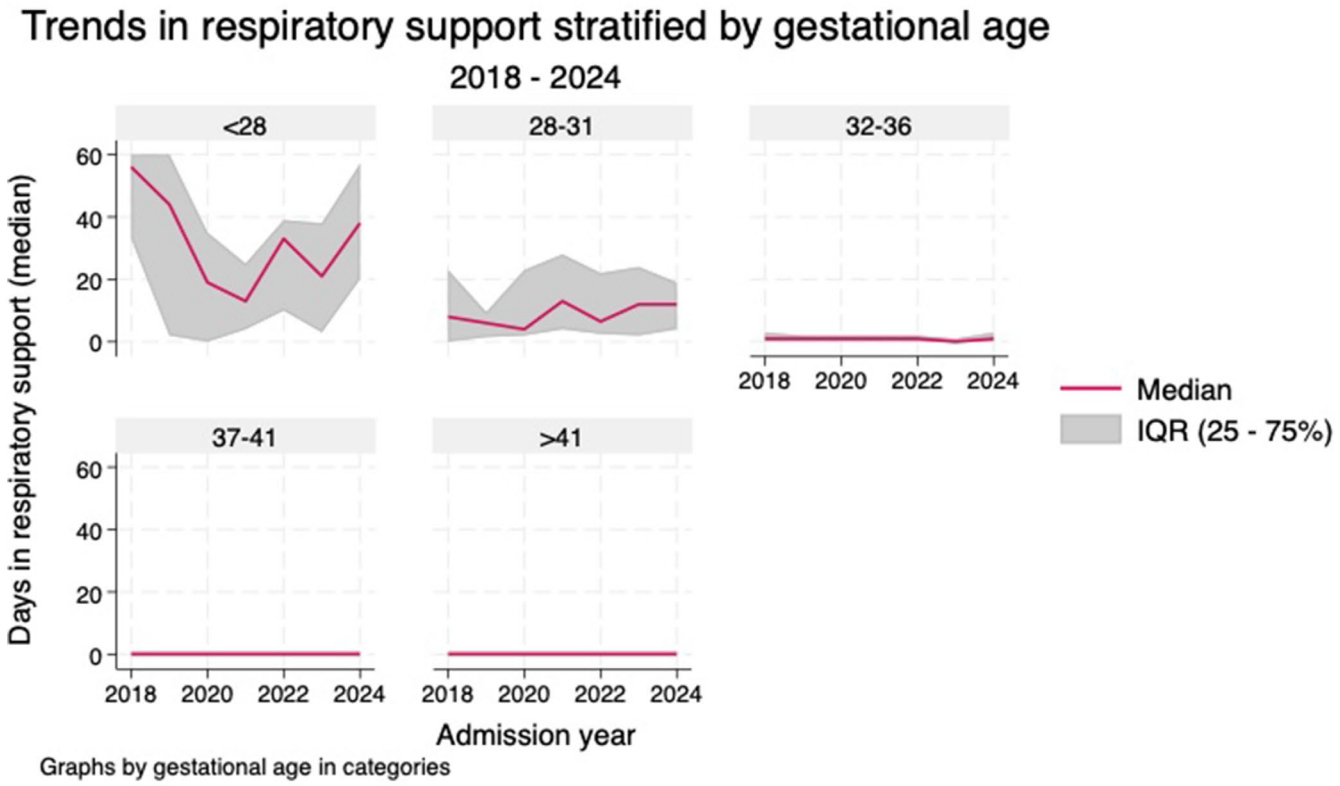


**FIGURE 4** | Yearly trends in median duration of respiratory support between 2018 and 2024 stratified by gestational age.

Organisation, a 10%–15% C-section rate is optimal in a healthy catchment population [26].

When compared with national data from Danish NICUs where 68% of preterm infants were exclusively breastfed at discharge [27], the rate observed in our unit is perceived to be higher. However, we cannot exclude infants receiving mothers' milk with bottle feeding. The high baseline prevalence of infants receiving mothers' milk raises the possibility of a ceiling effect, whereby the implementation of couplet care may not result in substantial further increases in breastfeeding rates and milk supply at discharge.

Nearly half of admitted infants required respiratory support. However, the overall short median duration indicated that respiratory morbidity was generally mild and transient. These findings suggest that a substantial proportion of infants are eligible for couplet care and early SSC shortly after admission to the NICU. Evidence from a 2025 Cochrane Review indicated that SSC may improve cardiorespiratory stability in infants [18]. Couplet care may have the potential to positively influence the duration of respiratory support, as infants cared for in couplet care units were more likely to initiate SSC earlier than in conventional NICUs [14]. The GA-dependent duration of respiratory support observed in this study provides

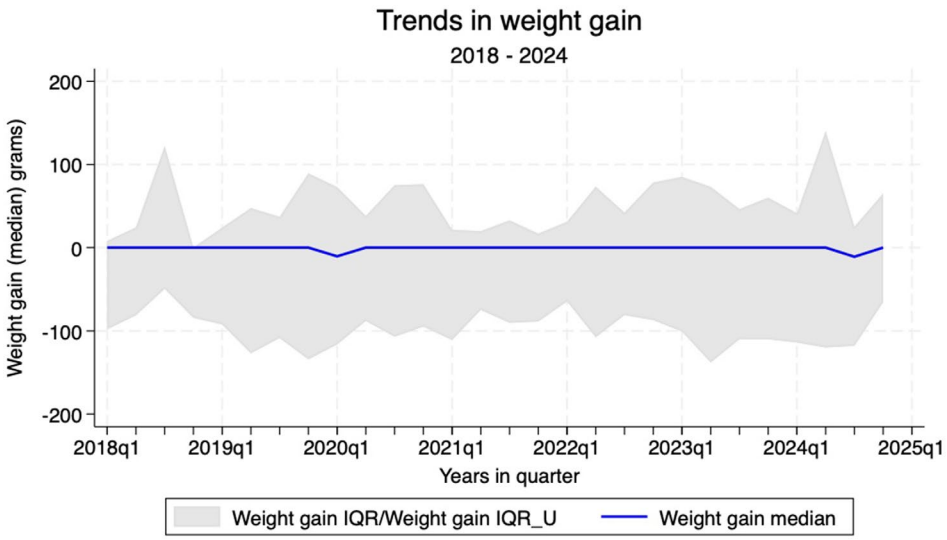


**FIGURE 5** | Quarterly trend in median weight gain between 2018 and 2024.

a framework for identifying which infants are most likely to benefit from couplet care.

The stable median weight gain observed across the seven-year period indicated that in-hospital growth outcomes were maintained during the existing model of care. This is important baseline information, as concerns are sometimes raised that changes in care structure may compromise nutritional monitoring or growth. Notably, a previous study comparing couplet care with standard NICUs design reported no difference in infant growth at discharge between groups [17]. Together, these findings suggest that growth outcomes are unlikely to be adversely affected by the implementation of couplet care.

### 4.1 | Strengths and Limitations

A considerable strength of the study was that all infants admitted to and discharged from the NICU were systematically entered into the Neobase register. The possibility of selection bias was thereby limited. The generalisability of the findings should be considered, as the study included data from only one hospital in Denmark. The hospital's wide catchment area encompassed patients and families from more deprived and vulnerable communities than other catchment areas in the region. This could limit the generalisability of the findings to other hospitals. However, the NICU functions as a level 2–3 unit, and this structure closely resembles that of most other hospitals in the region and nationwide. This supports some degree of comparability. The observed trends may, to some extent, be replicated to other NICUs in Denmark. A limitation of this study was that certain inaccuracies and missing data were present in the Neobase, which may have affected data quality and validity. The inaccuracies were partly attributable to the data entry process. As such, errors were likely due to typographical mistakes or incorrect data entry during transcription, leading to random misclassification. The study was based on secondary data, collected independently of the study and its specific research purposes. Secondary data can serve as a valuable and cost-effective alternative to primary data in epidemiologic research [28]. However, disadvantages can arise from the researcher's limited control over the selection of variables, the participants included and the quality of information [29]. In this study, we lacked data on length of stay and SSC, which are valuable clinical outcomes when examining couplet care. A further limitation was that this study focused solely on delivery and infant outcomes. Couplet care is designed to support the mother-infant dyad, with potential benefits for both infants and mothers, as both are considered patients receiving care together. Important maternal outcomes such as indications for delivery, pain management, mobilisation and breastfeeding were not assessed in the present study. Future research examining the feasibility and impact of couplet care should therefore include maternal outcomes alongside infant outcomes to provide a more comprehensive evaluation of the model.

## 5 | Conclusion

This register-based study provided a baseline description of clinical outcomes among infants admitted to a Danish level 2–3 NICU before the implementation of couplet care in 2025. Key outcomes considered sensitive to couplet care and reduced separation, such as nutrition at discharge, duration of respiratory support, and weight gain during admission, remained stable over the seven-year period. The predominance of vaginal delivery supports the feasibility of early maternal–infant proximity, although the high C-section rate may limit immediate initiation for some dyads. These findings establish an essential reference for the prospective evaluation of couplet care implementation. The findings will facilitate attribution of future changes in infant outcomes to organisational and care-model interventions rather than underlying temporal trends.

#### Author Contributions

**Anne Brødsgaard:** writing – review and editing, supervision, methodology. **Michella Bjerregaard:** conceptualization, methodology, writing – original draft, formal analysis, writing – review and editing. **Emma Malchau Carlsen:** writing – review and editing, supervision, conceptualization, methodology. **Anna Axelin:** methodology,

writing – review and editing, supervision. **Ingrid Poulsen:** methodology, writing – review and editing, supervision.


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### Conflicts of Interest

The authors declare no conflicts of interest.

### Data Availability Statement

The analysed data are included in this published article and its additional files or are available from the corresponding author at reasonable request.

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## Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Delivery mode stats according to year. **Table S2:** Nutrition stats according to year. **Table S3:** Respiratory support stats according to year and GA.