Accepted: 28 March 2023 | Published Online 20 April 2023

DOI: 10.1111/1471-0528.17502

BJOG An International Journal of Obstetrics and Gynaecology

RESEARCH ARTICLE

Epidemiology

Busy day effect on adverse obstetric outcomes using a nationwide ecosystem approach: Cross-sectional register study of 601 247 hospital deliveries

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Funding information
Helsinki university hospital, EVO Grant, Grant/Award Number: THY Y1017N0183; Suomen Akatemia; Suomen Kulttuurirahasto, Grant/Award Number: 00211163; The Federation of Finnish Midwives

Abstract

Objective: To study the busy day effect on selected neonatal adverse outcomes in different sized delivery hospitals and in the entire nationwide obstetric ecosystem.

Design: A cross-sectional register study.

Setting: The lowest and highest 10% of the daily delivery volume distribution were defined as quiet and busy days, respectively. The days between (80%) were defined as optimal delivery volume days. The differences in the incidence of selected adverse neonatal outcome measures were analysed between busy versus optimal days and quiet versus optimal days at the hospital category and for the entire obstetric ecosystem level.

Population: A total of 601 247 singleton hospital deliveries between 2006 and 2016, occurred in non-tertiary (C1–C4, stratified by size) and tertiary level (C5) delivery hospitals.

Methods: Analyses were performed by the methods of the regression analyses with crude and adjusted odds ratios including 99% CI.

Main outcome measures: Birth asphyxia.

Results: At the ecosystem level, adjusted odds ratio for birth asphyxia was 0.81 (99% CI 0.76–0.87) on busy versus optimal days. Breakdown to hospital categories show that adjusted odds ratios for asphyxia on busy versus optimal days in non-tertiary hospitals (C3, C4) were 0.25 (99% CI 0.16–0.41) and 0.17 (99% CI 0.13–0.22), respectively, and in tertiary hospitals was 1.20 (99% CI 1.10–1.32).

Conclusions: Busy day effect as a stress test caused no extra cases of neonatal adverse outcomes at the ecosystem level. However, in non-tertiary hospitals busy days were associated with a lower and in tertiary hospitals a higher incidence of neonatal adverse outcomes.

KEYWORDS
asphyxia, busy day, delivery hospital, obstetrics, quality of care

1 | INTRODUCTION

The importance of the quality improvement processes in health care was noticed at the end of the 20th century when hospital-level data collection, analyses and dissemination of recognised risk factors, mortality and complications of given care led to declining hospital-level mortality rates.[1] In obstetrics, the quality evaluation of given care is often based on single-centre studies and quality improvement efforts vary by measurement tools, study aims and effectiveness.[2–5] The common quality indicators, such as maternal and perinatal mortality rates, are very low in high-income countries and individual cases are not always preventable.[6–8] Earlier studies have shown that it is possible to evaluate the quality of care by the size of the delivery hospital.[9–13] Different sized hospitals have variations in their referral policies to tertiary units; however, details of these individual policies are not always available and have not been extensively evaluated. However, the outcomes are considered to be comparable between similar levels of hospitals,[14,15] and may improve[11,16–18] if the referral system between smaller and larger hospitals functions well and is used appropriately. Therefore, evaluation of the whole obstetric ecosystem rather than comparisons between single hospitals is challenging because of differences in hospital-level patient mix and transfer policies as well as because of the unpredictable timing of natural birth.[6–8,19]

The size of the delivery hospital may be associated with the relative delivery hospital level busyness and the busyness experienced may vary between different sized delivery hospitals, as well as from day to day.[20] The common assumption is that busyness in obstetric units can jeopardise the quality and even the safety of obstetric care, but the evidence on this phenomenon is very limited.[21] Our previous studies showed an association between the varying daily delivery volume and the occurrence of maternal adverse outcomes[22] and on the varying use of obstetrical interventions during labour on busy days in different sized delivery hospitals.[23]

From the perspective of varying time periods, considering weekdays and weekends, only a few studies in obstetrics suggest that giving birth during weekend[24–26] or outside office hours[27] can be considered a risk factor for quality of obstetric care. However, results are partly contradictory. Increased risk may be related to the capability to handle variation in daily patient flow variations between weekends and weekdays.[25] Weekends have a different profile with patient management leading to fewer obstetric interventions.[28]

To understand how the whole obstetric ecosystem works, the quality of obstetric care should primarily be measured at the level of the nationwide obstetric ecosystem and only secondly as a breakdown of data per single delivery hospital. To study how the obstetric ecosystem reacts to stress and whether the busy day effect is supported by clinical data, we conducted a cross-sectional study using nationwide population-based registries on the association between the busy day effect and the main outcome measure birth asphyxia, and the secondary outcome measures defined as obstetric emergency-related interventions, and perinatal mortality on the entire nationwide obstetric ecosystem and the different size delivery hospitals.

2 | METHODS

Finland is a Nordic country with 5.5 million inhabitants. In the light of the lowest maternal and neonatal mortality in nationwide comparison, Finland is one of the safest countries in which to give birth.[6,29,30] Finland has a publicly funded maternity care system, used by 99% of pregnant women. Private delivery services are not available. During the study period, there were 21 hospital districts with five catchment areas. The catchment areas offer highly specialised medical care in five university hospitals. The Finnish obstetric ecosystem encompasses delivery hospitals with varying annual patient flow and profile, depending on population density and the level of needed maternity care. Local and central-level delivery hospitals provide secondary-level maternity care, while tertiary care is implemented through the five university-level hospitals. The Finnish delivery hospitals have a referral system to achieve shared care that covers the entire country.[31] High-risk pregnancies and very preterm deliveries (<32 weeks of gestation), as well as fetuses with very low birthweight (<1500 g), are referred to university-level hospitals. The referral system works between local, central and university-level hospitals as well as between the five university-level delivery hospitals. Fetuses with diagnosed congenital heart disease or other severe structural abnormalities or otherwise most complicated pregnancies are treated at the capital area university-level hospital. Fetal invasive procedures are performed only in university hospitals and fetal surgery is performed exclusively in Helsinki University Hospital, to where also most of the cases requiring neonatal surgery are referred from the whole country. In addition, local hospitals transfer not only complicated and preterm pregnancies to central hospitals but also normal pregnancies if they are coming close to their maximum capacity of daily patient flow, when they become overloaded. Also, new incoming patients may be referred to another delivery hospital located near the patient's place of residence.

This cross-sectional register study was conducted using data from the Finnish Medical Birth Register (MBR) founded in 1987. The MBR includes all live births and stillbirths with a birthweight of at least 500 g or gestational age of at least 22 weeks and contains information on maternal reproductive and obstetric history, care and interventions during pregnancy and birth, and newborn outcomes and interventions until the age of 7 days. The MBR data are collected from all the Finnish delivery hospitals and supplemented with information from the civil registry and Statistics Finland with high-quality information and good coverage.[32,33] The selected data for this study included information on 601 247 singleton deliveries from 26 Finnish delivery hospitals in 2006–2016. Multiple pregnancies (n = 9149) and deliveries (n = 24 414) that took place in very small delivery hospitals (n = 8) that closed due to low annual delivery volume during the study period were excluded from the total data (N = 634 810). Ethical approval was not needed because informants were not contacted at any part of this study, and only pseudonymised data were used.

For the study setting, all 26 delivery hospitals were stratified into five categories (C1–C5) based on their annual delivery volume and profile. Category C1 included seven local and central-level delivery hospitals with fewer than

1000 annual deliveries, C2 included ten and C3 included two local and central-level delivery hospitals across the country, with annual delivery volumes from 1000 to 1999 and from 2000 to 2999, respectively. Hospital category C4 included two central-level delivery hospitals near the capital area with 3000 or more annual deliveries. Hospital category C5 included five university hospitals with a profile of treating the most complicated cases. The previously described delivery hospital referral system covers the whole country. Some of the extremely high-risk pregnancies and all extremely preterm deliveries are referred to Helsinki University Hospital. Managing the university hospitals as one category in this study setting enables more reliable analyses because of differences in patient risk profiles between university hospitals and other similar sized delivery hospitals. The deliveries of fetuses of less than 32 weeks gestation are centralised to the university hospitals as well as estimated high-risk births to the higher-level hospitals (C4 and C5) to ensure standardised care for high-risk pregnancies, affecting the patient-mix in C4 and C5 hospitals.[34]

The exposure of this study was the daily delivery volume categorised as quiet, optimal and busy days. To define these categories, we determined the daily delivery volume for each day in each of 26 delivery hospital in 2006–2016 based on the MBR data and pooled the information in each of five hospital categories (C1–C5). Days with the highest and lowest 10% of daily distribution on deliveries in each hospital category were categorised as busy and quiet days, respectively. Approximately 80% of the days between the busiest and most quiet days were defined as optimal delivery volume days. The varying number of daily deliveries was used as a proxy for the busy day effect. A day in this study was defined as 24 hours, from midnight to midnight.

The main outcome measure of this study was birth asphyxia. Selected secondary outcome measures were emergency-related interventions including newborn resuscitation, respiratory care, neonatal intensive care unit (NICU) admission and perinatal mortality, which are often but not solely associated with or secondary to birth asphyxia. Selection of outcome measures was made based on the earlier identified quality indicators of obstetric care,[6,35] as well as data availability in MBR. Birth asphyxia included all asphyxia diagnoses according to the tenth revision of the International Statistical Classification of Diseases and Health-Related Problems (ICD) O68, P20 or P21 and/or results of analysed umbilical cord vein or artery blood sample pH less than 7.05. Resuscitation included only newborns that required intubation. Respiratory care included situations when respiratory care was needed during neonatal care in first 7 days. Care in the NICU was defined as a transfer of the newborn from the delivery hospital to NICU in first 7 days, only live births were included. Perinatal mortality was defined as intrauterine death from 22 weeks of gestation or early neonatal mortality in first 7 days.

We performed several logistic regression analyses and calculated crude (cOR) and adjusted (aORs) odds ratios with 99% CI to study the effect of busy days on birth asphyxia, obstetric emergency-related interventions and perinatal mortality with two different comparisons: busy versus optimal, and quiet versus optimal days. Optimal days were used as a reference category in both comparisons. The analyses were performed separately for each five outcome measures for all delivery hospital categories together (total population, C1–C5 pooled) and separately for the five delivery hospital categories (C1–C5). Possible confounders adjusted in the logistic regression analyses were determined based on descriptive statistics and previous studies to consider the effect of case mix: maternal age (<25, 25–34, ≥35 years), parity (nulliparous, no previous deliveries; multiparous, one or more previous deliveries), gestational age in weeks ($\leq 34^{+0}$, 34^{+1}–37^{+0}, $>37^{+1}$), delivery mode (vaginal delivery including breech, instrumental delivery including vacuum extraction assisted delivery and forceps), all caesarean sections (including elective and emergency sections), pre-eclampsia and gestational diabetes mellitus. In addition, sensitivity analyses to study the effect of weekday categorised as weekday versus weekend (Saturday and Sunday) on the association between daily delivery volume and adverse neonatal outcomes were performed. In general, the proportion of missing information on delivery characteristics was very low (<0.2%). Nominal statistical significance was considered for p values less than 0.01. Statistical analyses were conducted with the software Statistical Package for Social Sciences version 26 (SPSS; IBM, Armonk, NJ, USA).

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Patients have not been involved at any part of this register-based study.

3 | RESULTS

Study population included 601 247 deliveries of which 55 448, 165 573, 54 574, 108 254 and 217 398 were in hospital categories C1 to C5, respectively (Table 1).

Maternal characteristics (parity, age in years, weeks of gestation, delivery mode, gestational diabetes, pre-eclampsia) by variations of the daily delivery volume in different sized delivery hospitals, C1–C5, are reported in Table S1.

The frequency of main outcome, birth asphyxia, varied in hospital categories C1–C5 as well as in total population between daily delivery volume categories (Table 2). In C3 and C4, frequencies of birth asphyxia were lowest (0.5% and 1.1%, respectively) on busy days compared with quiet days (3.5% and 5.8%, respectively) and optimal days (1.7% and 5.3%, respectively). In C5 (university hospitals), frequencies of birth asphyxia were 1.8%, 4.9% and 5.8% on quiet, optimal and busy days, respectively. In the total population (C1–C5 pooled), frequencies of birth asphyxia were 2.8%, 3.9% and 3.3% on quiet, optimal and busy days, respectively (Table 2).

Odds of birth asphyxia was 19% lower (aOR = 0.81, 99% CI 0.76–0.87) on busy versus optimal days overall at the

TABLE 1 Daily delivery volume distribution on quiet, optimal and busy days in each delivery hospital category and in total.

	C1	C2	C3	C4	C5	Total
Frequency of delivery hospital	7	10	2	2	5	26
Deliveries, *n* (%)	55 448 (9.2)	165 573 (27.5)	54 574 (9.1)	108 254 (18.0)	217 398 (36.2)	601 247 (100)
Range of daily deliveries	1–10	1–16	1–19	1–34	1–30	1–34
Mean of daily deliveries	2.0	4.6	4.5	13.5	10.8	7.1
Quiet days, *n* (%)	7212 (13)	14 200 (8.6)	5303 (9.7)	9731 (9.0)	24 613 (11.3)	61 059 (10.2)
Range of deliveries on quiet days	1	1–2	1–4	1–8	1–7	1–8
Optimal days, *n* (%)	44 056 (79.5)	711 136 (82.6)	42 698 (78.2)	88 156 (81.4)	171 148 (78.7)	482 769 (80.3)
Range of deliveries on optimal days	2–5	3–8	5–11	9–23	8–18	2–23
Busy days, *n* (%)	4180 (7.5)	14 662 (8.9)	6573 (12.0)	10 367 (9.6)	21 637 (10.0)	57 419 (9.1)
Range of deliveries on busy days	6–10	9–16	12–24	24–34	19–30	6–34

Note: Quiet days, deliveries that occurred during the closest 10% of the lowest daily delivery volume days. Optimal days, deliveries that occurred between the lowest (10%) and highest (10%) delivery frequency days. Busy days, deliveries that occurred during the closest 10% of the highest daily delivery volume days. C1, Delivery hospitals with <1000 annual deliveries. C2, Delivery hospitals with 1000–1999 annual deliveries. C3, Delivery hospitals with 2000–2999 annual deliveries. C4, Delivery hospitals with ≥3000 annual deliveries. C5 = University hospitals.

ecosystem level after adjustment for maternal age, parity, gestational age in weeks, delivery mode, pre-eclampsia and gestational diabetes mellitus (Figure 1, Table S2). In C5 hospitals, including university-level hospitals only, odds of birth asphyxia were 20% higher (aOR = 1.20, 99% CI 1.10–1.32), and in C3 and C4, 75% and 83% lower (aOR = 0.25, 99% CI 0.16–0.41; aOR = 0.17, 99% CI 0.13–0.22, respectively) on busy versus optimal days (Figure 1, Table S2). When comparing quiet days with optimal days, odds of birth asphyxia were 28% lower (aOR = 0.72, 99% CI 0.68–0.78) overall at the ecosystem level (Figure 2, Table S2). In C5 hospitals, odds of birth asphyxia were 66% lower (aOR = 0.34, 99% CI 0.30–0.39), and in C3 and C4 hospitals they were 125% and 42% higher (aOR = 2.25, 99% CI 1.79–2.82; aOR = 1.42, 99% CI 1.24–1.62, respectively) on quiet days compared with optimal days (Figure 2, Table S2).

Overall, at the ecosystem level, NICU admission was 5% (aOR = 0.95, 99% CI 0.91–0.99) lower on busy compared with optimal days. Odds of other secondary outcomes did not vary on busy compared with optimal days (Figure 1, Table S2). When comparing quiet days to optimal days only odds of resuscitation varied significantly, and it was 20% (aOR = 0.80, 99% CI 0.71–0.91) lower on quiet compared with optimal days (Figure 2, Table S2).

Sensitivity analyses of busy day effect on birth asphyxia, obstetric emergency-related interventions and perinatal mortality showed no statistically significant differences in comparison between weekdays and weekends (data available on reasonable request).

4 | DISCUSSION

4.1 | Main findings

Using nationwide register data from 26 delivery hospitals including 601 247 singleton hospital deliveries we observed that the busy day effect as a stress test at the ecosystem level caused no extra cases of birth asphyxia or any other secondary adverse outcomes. In other words, the overall capacity did not reach critical limits, suggesting that adding resources to the ecosystem would not be likely to improve the outcomes. However, breakdown to hospital categories showed that the distribution of birth asphyxia cases between hospitals was very different depending on the daily patient flow. In non-tertiary hospitals, busyness resulted in a decrease and in tertiary hospitals it resulted in an increase in birth asphyxia, possibly due to different patient transfer policies under stress. Interestingly, quiet compared with optimal days showed the opposite pattern in the prevalence of birth asphyxia with busy days in tertiary university hospitals paradoxically seeming to be as safe as quiet days in large non-tertiary hospitals (C4) in terms of birth asphyxia.

Birth asphyxia was the main outcome because prevention and recognition of asphyxia are the ultimate and uncompromised safety goals in obstetric care.[36–39] Secondary outcomes on the other hand may result from birth asphyxia, but also from other causes that are not directly related to resources or quality of care. For example, stillbirth cases, included in perinatal deaths, can be transferred upward to larger hospitals to allow more detailed examination of causes behind the event. Additionally, fetuses with antenatally diagnosed aneuploidies and severe structural abnormalities with expected fatal outcome often experience intrapartum death or birth asphyxia because they do not receive active treatment during labour and only comfort care after birth. Furthermore, NICU admission or neonatal ventilation may be related to differences in treatment practices between different hospitals and physicians and theoretically they may also vary with the resources in use.[40] However, diagnostic methods and data collection regarding cases of birth asphyxia cases are unlikely to be different between different sized delivery hospitals. Furthermore, conditions leading to asphyxia such as placental and umbilical cord complications are rare and

TABLE 2 Outcome measures categorised by quiet, optimal and busy delivery volume days in five different sized delivery hospital categories and for the total obstetric ecosystem.

Outcome measure	Delivery hospital	Quiet days	Optimal days	Busy days	Total
Birth asphyxia (*n*, %)	C1	125 (1.7)	627 (1.4)	40 (1.0)	792 (1.4)
	C2	376 (2.6)	4279 (3.0)	463 (3.2)	5118 (3.1)
	C3	184 (3.5)	744 (1.7)	31 (0.5)	959 (1.8)
	C4	561 (5.8)	4652 (5.3)	114 (1.1)	5327 (4.9)
	C5	453 (1.8)	8306 (4.9)	1257 (5.8)	10 016 (4.6)
	Total	1699 (2.8)	18 608 (3.9)	1905 (3.3)	22 212 (3.7)
Newborn resuscitation (*n*, %)	C1	30 (0.4)	239 (0.5)	20 (0.5)	289 (0.5)
	C2	60 (0.4)	498 (0.4)	39 (0.3)	597 (0.4)
	C3	13 (0.2)	93 (0.2)	25 (0.4)	131 (0.2)
	C4	123 (1.3)	1282 (1.5)	157 (1.5)	1562 (1.4)
	C5	256 (1.0)	2221 (1.3)	328 (1.5)	2805 (1.3)
	Total	482 (0.8)	4333 (0.9)	569 (1.0)	5384 (0.9)
Respiratory care (*n*, %)	C1	32 (0.4)	202 (0.5)	16 (0.4)	250 (0.5)
	C2	74 (0.5)	584 (0.4)	40 (0.3)	698 (0.4)
	C3	21 (0.4)	156 (0.4)	40 (0.6)	217 (0.4)
	C4	58 (0.6)	795 (0.9)	142 (1.4)	995 (0.9)
	C5	494 (2.0)	3117 (1.8)	377 (1.7)	3988 (1.8)
	Total	679 (1.1)	4854 (1.0)	615 (1.1)	6148 (1.0)
NICU admission (*n*, %)	C1	667 (9.2)	3744 (8.5)	264 (6.3)	4675 (8.4)
	C2	1499 (10.6)	14 619 (10.7)	1599 (10.9)	17 717 (10.7)
	C3	582 (11.0)	4955 (11.6)	809 (12.3)	6346 (11.6)
	C4	638 (6.6)	5517 (6.3)	750 (7.2)	6905 (6.4)
	C5	3672 (14.9)	21 035 (12.3)	2421 (11.2)	27 128 (12.5)
	Total	7058 (11.6)	49 870 (10.3)	5843 (10.2)	62 771 (10.4)
Perinatal mortality (*n*, %)	C1	25 (0.3)	138 (0.3)	14 (0.3)	177 (0.3)
	C2	46 (0.3)	442 (0.3)	39 (0.3)	527 (0.3)
	C3	9 (0.2)	155 (0.4)	26 (0.4)	190 (0.3)
	C4	31 (0.3)	234 (0.3)	23 (0.2)	288 (0.3)
	C5	122 (0.5)	899 (0.5)	148 (0.7)	1169 (0.5)
	Total	233 (0.4)	1868 (0.4)	250 (0.4)	2351 (0.4)

Note: C1, Delivery hospitals with <1000 annual deliveries. C2, Delivery hospitals with 1000–1999 annual deliveries. C3, Delivery hospitals with 2000–2999 annual deliveries. C4, Delivery hospitals with ≥3000 annual deliveries. C5, University hospitals. NICU, Neonatal Intensive Care Unit. Quiet days, deliveries that occurred during the closest 10% of the lowest daily delivery volume days. Optimal days, deliveries that occurred between the lowest (10%) and highest (10%) delivery frequency days. Busy days, deliveries that occurred during the closest 10% of the highest daily delivery volume days.

by nature randomly occurring events with no associations with patient flow at the ecosystem level. We therefore believe that the ability to recognise and react to suspected asphyxia is a good quality indicator for measuring how well hospitals perform under stress.

4.2 | Strengths and limitations

The strengths of this study are the novel and unique ways used to analyse associations between the busy days and birth asphyxia, NICU-related interventions and perinatal mortality at the total obstetric ecosystem level as well as at single delivery hospital level. In addition, the results are based on the large number of data collected from a high-quality population-based registry.[33,41] The large database, comprising the entire delivery hospital network, was optimal to understand the way the obstetric ecosystem reacts under varying levels of stress. The generalisability of the results depends on the entire capacity of the ecosystem, organisation of care, transfer policies and local treatment differences. In addition, the daily patient flow on the other hand may not serve as the optimal surrogate marker for busy days, because outcome measures are also related to the occurrence of risk factors compared with the total number of daily deliveries, not the actual busy, perhaps short, time windows in delivery hospitals. The day of admission has limitations when patients who are not going to give birth during their visit are

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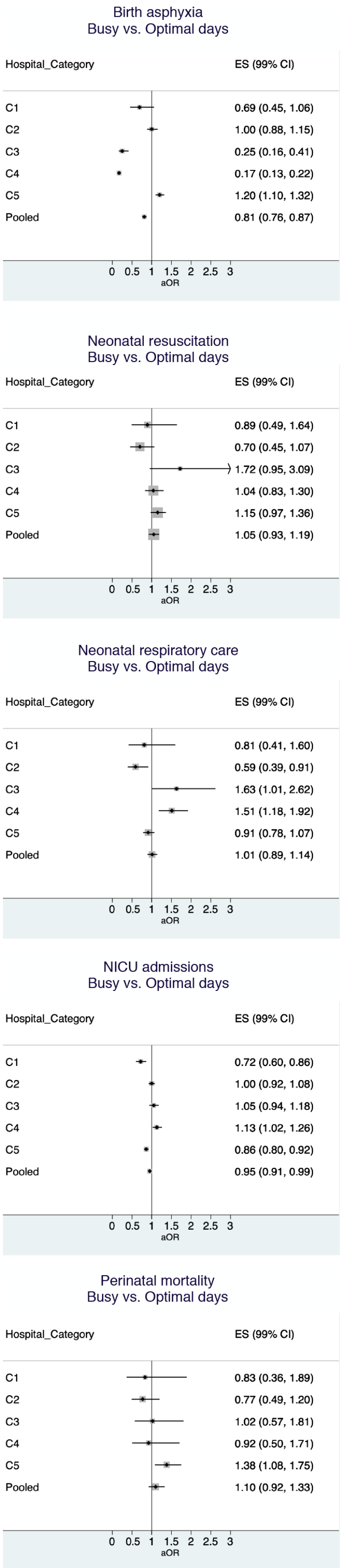

FIGURE 1 Adjusted odds ratios (99% CIs) of the busy days compared to optimal days (reference category) of outcome measures in five hospital categories and in the entire obstetric ecosystem (pooled).

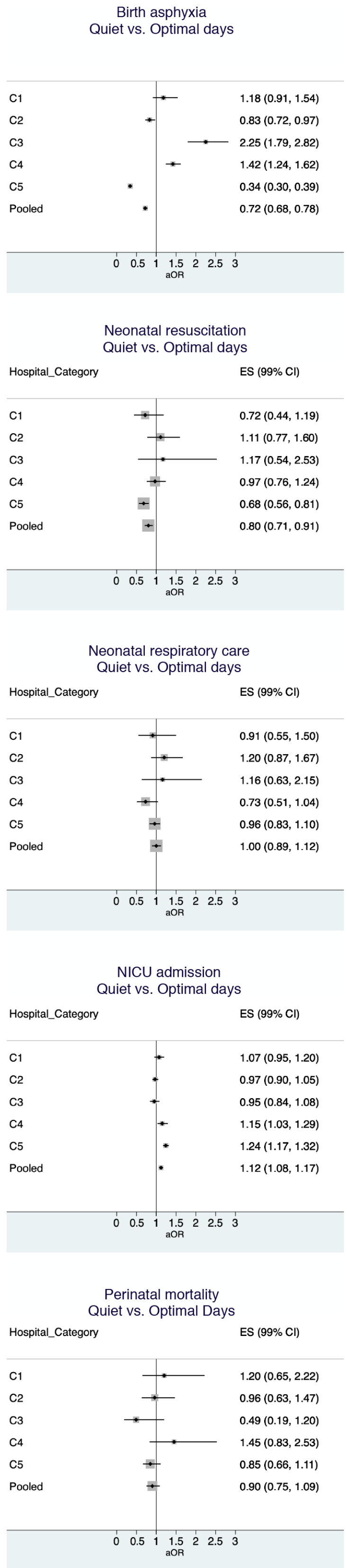

FIGURE 2 Adjusted odds ratios (99% CIs) of the quiet days compared to optimal days (reference category) of outcome measures in five hospital categories and in the entire obstetric ecosystem (pooled).

also included. We also assume that the effect of the various stages of labour is independent of the exposure in the entire data set even though the effect may be critical if looked at on a daily basis. Also, the number of daily deliveries was represented as a homogeneous mass of deliveries, the number of deliveries per day. This is not the way deliveries usually occur in the delivery hospitals, as deliveries occur any time and deliveries are seldom identical in comparison with each other. A limitation of this study is that the staffing, skill mix and acuity mix on the units is not fully available even if some indicators of acuity were. To fill this gap, hospital-based detailed information would have been needed, but such an approach would miss the ecosystem aspect, which is the novelty of this study. Furthermore, human resources and the timing of patient transfers are beyond the scope of this study. The limitation of the study is also considered to be the definition of perinatal death, which included intrauterine deaths occurring before the active stage of labour and not only intrapartum deaths.

4.3 | Interpretation

Based on clinical experience we assume that the risk of human errors increases when in a hurry and consequently busy days are expected to increase the incidence of adverse outcomes.[21,42–44] Unexpectedly, our results did not support this concept because the whole obstetric ecosystem was capable of maintaining the quality of care under stress. At the hospital level, however, asphyxia incidence appeared to be the sum effect of both hospital capacity and transfer policy. On quiet days the transfer policy favours treatment of high-risk cases at large non-tertiary hospitals and on busy days it favours treatment in tertiary hospitals. Consequently, within the ecosystem, the patient-mix between non-tertiary and tertiary hospitals changes with patient flow. Possibilities for patient flow management could be considered in different sized delivery hospitals.[45–48]

5 | CONCLUSIONS

The obstetric ecosystem tolerated stress with no safety concerns as during the busiest 10% of all days the risk of birth asphyxia was lower than on the rest of the days with a similar lack of negative impact applied also to the secondary obstetric outcomes. Under stress, however, there were remarkable changes within the ecosystem between different hospital categories, most likely due the referral of high-risk pregnancies on busy days with a very low threshold from large non-tertiary hospitals to tertiary hospitals. On the other hand, during quiet days the preparedness of medical risk-taking with moderate- or high-risk cases may have been higher even in non-tertiary hospitals. As university hospitals are at the end of the referral path, the transfer system resulted during busy days in a case-mix where high-risk pregnancies become concentrated in tertiary hospitals and are diluted in non-tertiary hospitals, the net effect being lack of effect at the ecosystem level. Overall, the busy day effect as an exposure should not be connected to asphyxia or to any other obstetric outcome at the hospital level without the corresponding information on what happens at the ecosystem level, which should be considered as a novel standard in this context. Quality improvement efforts should therefore be taken not only at a single delivery hospital level but should encompass the whole obstetric ecosystem.

AUTHOR CONTRIBUTIONS

The study was conceived by SH and designed by RV, SR, MG and SH. The data were acquired and collated by RV and analysed by RV, SR and IK. The manuscript was drafted and revised critically for important intellectual content by all authors (RV, SR, MG, IK, VS and SH). All authors gave final approval of the version to be published. The corresponding author (RV) attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. The guarantor (SH) accepts full responsibility for the work, had access to the data and controlled the decision to publish.

ACKNOWLEDGEMENTS

We thank the Finnish Institute of Health and Welfare (THL) for approval of the use of the Medical Birth Register (MBR) data.

FUNDING INFORMATION

Finnish Cultural Foundation (00211163), HUS Helsinki University Hospital (HUS) -EVO Grant (THY Y1017N0183), The Federation of Finnish Midwives (N/A) and Academy of Finland (N/A). RV was supported by grants from the Finnish Cultural Foundation (00211163), HUS Helsinki University Hospital (HUS) -EVO Grant (THY Y1017N0183) and The Federation of Finnish Midwives (N/A). IK was supported by a grant from the Academy of Finland (N/A). The funders did not have any role in this study process, including all data collection and analyses, results and reporting.

CONFLICT OF INTEREST STATEMENT

Ilkka Kalliala is a Board Member of the Finnish Colposcopy Society, with no financial support. Vedran Stefanovic is a Broad Member of the International Society for Placenta Accreta Spectrum (https://is-pas.org/), with no financial support. Other authors have no conflicts of interest to disclose. Completed disclosure of interests form available to view online as supporting information.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS APPROVAL

Not required, because informants were not involved in this cross-sectional register-based study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Vilkko R, Räisänen S, Gissler M, Stefanovic V, Kalliala I, Heinonen S. Busy day effect on adverse obstetric outcomes using a nationwide ecosystem approach: Cross-sectional register study of 601 247 hospital deliveries. BJOG. 2023;130(11):1328–1336. https://doi.org/10.1111/1471-0528.17502