

Do Organisational Circumstances in the Birth Ward Influence Perinatal Outcome? A Retrospective Analysis of Over 43.000 Deliveries

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ABSTRACT

Background: Birth can be a high-risk situation requiring identification of potential complications and decisive action. Identifying times of increased risk with respect to working patterns is important to optimise quality and safety. The umbilical cord pH and the 1-minute APGAR score are evaluated predictive parameters for the neonatal outcome. Aberrant values may be related to many factors, including special circumstances during birth.

Objectives: In this study, we checked the data of our hospital to find out, whether the day, the time of birth, as well as the Hand Over Times (HOT), may be correlated to conspicuous findings.

Methods: This retrospective cohort study included deliveries of 20 years. The impaired fetal outcome was defined as pH values <7.15 and APGAR scores <8, since these values go along with a worse outcome. We looked at the birth pH and the 1-minute APGAR score with respect to the time, the weekday, day-and nighttime, and medical staff HOT. Inclusion criteria consisted of term pregnancies with a singleton pregnancy. Exclusion criteria were multiparas, twin pregnancies, premature births, intrauterine fetal deaths, and unknown gestational age.

Results: No significant difference between the weekdays, with this threshold, were recorded. In the comparison between day, nighttime significant fewer pH values <7.05 were recorded.

The analysis of the HOT showed no significant result for a pH value <7.15 and an APGAR score <8 except for the midwife HOT. Here significant fewer deliveries were shown with a pH value of 7.10-7.15 as well as an APGAR score >6.

Conclusion: These results demonstrate a high standard of care during the different days, times, and HOT over the last decades despite an increased workload. As the neonatal outcome depends on various factors, further studies are necessary to improve the working environment.

Keywords: Neonatal outcome; Fetal umbilical cord pH; APGAR score; Time of birth; Hand overtimes

INTRODUCTION

In obstetrics, there is a rising workload due to the increasing number of births and legal requirements, a shortage of staff, minimising the risk of adverse outcomes, and the centralisation of birth centres. Governments aim to close smaller departments in favour of specialised major medical centres. Working conditions in hospitals are often long. Traditional 24+h shifts go

along with fatigue, due to sleep deprivation and a high workload. In Australia and New Zealand, it is known that obstetric and gynaecology trainees work about 53,3 hours per week and have high rates of long days and 24 shifts with minimal sleep up to 1-2 hours [1]. Sleep deprivation due to extended working hours and circadian disruption has long been a concern in medicine [2] data are showing beyond a doubt that fatigue impairs human performance [3,4]. The effect of sleep

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deprivation on a cognitive test involves tracking is equivalent to a blood alcohol concentration of 0.10 percent [5,6] Previous studies have identified higher mortality in patients admitted on weekends across a range of medical conditions—a phenomenon termed the “weekend effect”. However, not all studies have identified an association between poor outcomes and out of hours periods [7-29].

This study investigates the neonatal outcome measured in pH- and APGAR values during the different weekdays, HOT, day- and nighttime.

Few studies have already been conducted to correlate the time of birth with the outcome of the neonates [11-19]. Caughey et al. [12] showed no significant association between the day, evening, and the nighttime and the neonatal birth outcome. For the neonatal outcome, they included the 5-minute APGAR score, a pH value as well as a transfer of the newborn to the pediatric intensive care unit [12]. This is in line with the results of Wolf et al. [13]. With regards to the hours worked prior to birth no difference could be shown in terms of a higher blood loss, a pH score <7.1, aborted vacuum extraction or fetal adaptive disorder [20]. Looking at intrapartum death Pasupathy et al. [21] published the effect of time and day of birth and the risk of neonatal death at term. The risk of neonatal death was 4.2 per 10 000 during the normal working week and 5.6 per 10 000 at all other times (out of hours). A higher rate of death out of hours was because of an increased risk of death ascribed to intrapartum anoxia.

This study focused on the fetal umbilical cord pH after birth and the 1-minute APGAR score as predictive outcome parameters [22] in our tertiary centre.

METHODS

This current study is a retrospective cohort study. The 20-year analysis is based on data between 1.1.1994 and 31.12.2014. The period is limited to 31.12.2014, on the one hand, due to a change of the information technology in 2015, on the other hand due to a change in the times of the shift work.

Records of primiparae, in which fetal cord blood pH and the 1-minute APGAR score were routinely measured and documented at birth, were analyzed. The birth time was rounded to the closest half hour (i.e. 8:44=> 8:30; 8:45=> 9:00).

The data was then divided in day- and nighttime (8 a.m-6 p.m./6 p.m-8 a.m); the different days of the week (Monday-Sunday); workdays (Monday-Thursday), Friday and weekend (Saturday, Sunday).

HOT on weekdays was defined as 6 a.m-6.30 a.m, 2 p.m-2.30 p.m, 10 p.m-10.30 p.m (midwives) and 8 a.m-8.30 a.m, 4 p.m-4.30 p.m (doctors), for Fridays it changed for the doctors to 8 a.m-8.30 a.m, 2 p.m-2.30 p.m. and on the weekends to 9 a.m-9.30 a.m, whilst the midwife HOT remained unchanged for Friday and weekends.

During the weekdays the normal staff setting includes up to 6 doctors from 8 a.m till 4 p.m and up to 5 midwives. Outside these core working hours, a shift consists of three doctors as well

as three midwives. HOT has not been outside the defined corridors for the period.

Further subgroups were formed according the pH value (<7.05; 7.05-7.09; 7.10-7.14; 7.15-7.19; 7.20-7.24; 7.25-7.29>7.30) and the APGAR Scores (0-2, 3-5, 6-7, 8-10). pH values <7.15 and APGAR scores <8 were defined as unfavorable outcomes. Inclusion criteria consisted of term pregnancies (36+ gestational weeks) with a singleton pregnancy. Exclusion criteria were multiparae, twin pregnancies, preterm births, intrauterine fetal deaths, and unknown gestational age.

Assessing the equal distribution per hour the ratio of deliveries over the different time corridors should match the ratio of time per corridor.

Therefore, a time ratio for day/night working hours and non-HOT/midwife HOT/doctor HOT was calculated. This ratio was then compared to the ratio of the number of deliveries during this time corridor. The ratio for day (10h)/night (14hrs) was 10/14. The HOT correlation was 81/13/7 (=non-HOT/midwife HOT/doctor HOT).

To answer our question regarding the safety of neonates in a tertiary hospital the next step was a repeat of this analysis with the pH- and APGAR subgroups.

The two hypotheses were an increase of medical care, due to the fact that there are more competent care providers on-site, and secondly a decrease of patient safety, due to a shift of attention.

A comparison between the HOT of the midwives, the HOT of the doctors, and no HOT was conducted. The study protocol was submitted to and approved by the ethics committee.

STATISTICAL ANALYSIS

Data analysis was performed with IBM SPSS Statistics (V24) and Microsoft Excel (V15.2). The distribution of the pH- and APGAR values over time are described in percent. Crosstables were implemented to estimate the association between deliveries during specific days, times, HOT and the fetal umbilical cord pH as well as the APGAR score.

To check for significance in deviation of appropriate rates Chi-Quadrat tests.

RESULTS

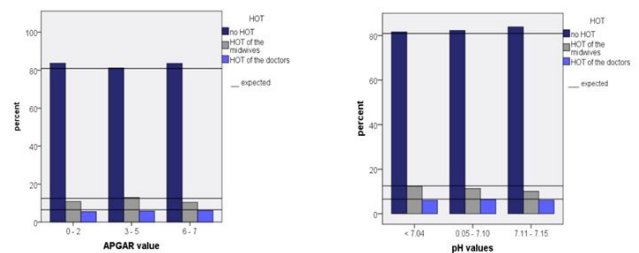


Figure 1: Distribution of the deliveries over time on different days. The highest birthrate was recorded at 9.30 a.m. from Monday to Friday. Decreased birth rates during the weekend.

General data

The data of 43745 singleton deliveries with a gestational age of 36+ weeks during this period were extracted from the birth database. Cord blood pH and the APGAR score results were missing in 336 deliveries, so 43.409 were included in this study.

The highest birthrate was recorded at 9.30 a.m from Monday to Friday (Figure 1). The distribution of deliveries over the weekdays is shown in Table 1.

A lower number of deliveries were recorded during the weekend, including Saturday and Sunday (Table 1).

Table 1: Distribution of deliveries, the APGAR scores, and the pH value over the days of the week (%) A lower number of deliveries were recorded during the weekend, including Saturday and Sunday as well as during the nighttime.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Nighttime	Daytime
Deliveries	15% (6529)	15.2% (6609)	14.5% (6295)	15.2% (6621)	14.2% (6155)	13.2% (5742)	12.27% (5539)	53.8% (23405)	46.2% (20085)
APGAR 0-2	0.2% (85)	0.23% (101)	0.20% (88)	0.2% (85)	0.2% (85)	0.2% (85)	0.2% (85)		
APGAR 3-5	0.76% (330)	0.6% (297)	0.70% (303)	0.76% (330)	0.76% (330)	0.76% (330)	0.76% (330)		
APGAR 6-7	1.1% (475)	1.11% (487)	1.105% (458)	1.1% (475)	1.1% (475)	1.1% (475)	1.1% (475)		
APGAR 8-10	13.0% (5639)	13.17% (5727)	13.21% (5734)	13.0% (5639)	13.0% (5639)	13.0% (5639)	13.0% (5639)		
pH<7.04	0.30% (130)	0.31% (136)	0.31% (136)	0.30% (130)	0.30% (130)	0.30% (130)	0.30% (130)		
pH<7.05-7.09	0.25% (108)	0.20% (89)	0.23% (89)	0.25% (108)	0.25% (108)	0.25% (108)	0.25% (108)		
pH<7.10-7.14	0.64% (277)	0.73% (317)	0.64% (280)	0.64% (277)	0.64% (277)	0.64% (277)	0.64% (277)		
pH<7.15-7.20	1.55% (673)	1.54% (670)	1.52% (663)	1.55% (673)	1.55% (673)	1.55% (673)	1.55% (673)		
pH<7.20-7.24	2.78% (1199)	2.65% (1152)	2.77% (1204)	2.78% (1199)	2.78% (1199)	2.78% (1199)	2.78% (1199)		
pH>7.25	9.52% (4142)	9.76% (4244)	9.0% (3912)	9.52% (4142)	9.52% (4142)	9.52% (4142)	9.52% (4142)		

Table 2: Ratio evaluation deliveries during HOT versus outside HOT.

	No HOT	HOT of the midwives	HOT of the doctors
Deliveries	83.4% (36270)2	10.6% (4616)2	83.4% (2604)2
APGAR group	0.2	0.12% (518)	0.15% (67)
	3-5	3.87% (1681)	0.62% (269)
	6-7	6.18% (2688)	0.78% (334)
pH Group	<7.04	1.66% (721)	0.25% (109)
	7.05-7.09	134% (582)	0.18% (80)
			0.10% (45)

Overall, 46.2% of the deliveries took time during the daytime, 53.8% at nighttime (Table 1). Compared with the expected ratio of 41.7% daytime/58.3% nighttime, this shows fewer deliveries during nighttime. 83.4% of the deliveries took time during 'no HOT', 10.6% during HOT of the midwives. 6.5% during the

HOT of the doctors (Table 2). Compared with the expected ratio of 80.9% 'no HOT'/12.5% 'HOT' of the midwives/6.5% 'HOT' of the doctors, these data show a reduction of deliveries during the HOT of the professionals.

Weekdays

The pH values and the APGAR groups were distributed over the weekdays according to the subgroups as in Table 1 demonstrated. The rate of births regarding the weekdays differed non-significantly with respect to cord pH <7.15 and an APGAR score <8. The same was found for the comparison between the subgroups of weekdays, Fridays and the weekend.

Night and daytime

In the comparison between day and nighttime fewer deliveries in all APGAR groups towards the nighttime were recorded. Significant less deliveries were recorded for all APGAR values >2 (APGAR 0-2: $p=0.19$; APGAR: 3-5 $p<0.001$; APGAR 6-7: $p<0.001$) (Figure 2).

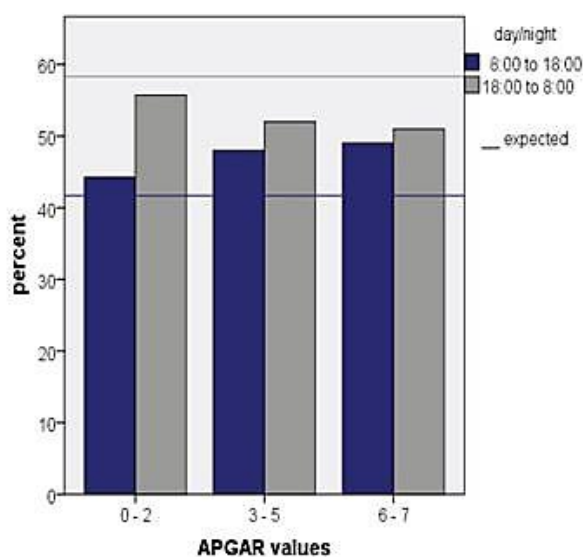


Figure 2: Distribution of the deliveries in the different APGAR groups during day and night time. The distribution to be expected, assuming equal distribution, is marked.

Comparing this with the pH values the following result was recorded: significant less deliveries as expected toward the night were shown for a pH value <7.04 ($p=0.017$). No significant result was shown for a pH value between 7.0-7.15 (pH 7.06-7.10 $p=0.465$; 7.10-1.15 $p=0.28$).

Hand over times (HOT)

The results of the ratio evaluation deliveries during HOT versus outside HOT is provided in Table 2. Due to a different amount of values in each time corridor the expected equivalent distribution would be 80.9% (no HOT): 12.5% (HOT of the midwives): 6.5% (HOT of the doctors).

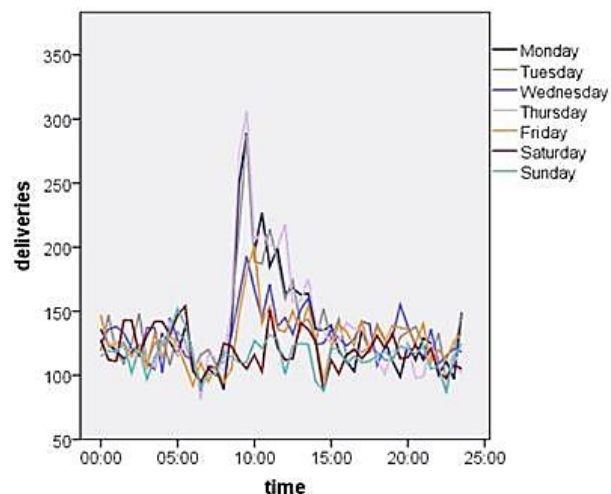


Figure 3: Distribution of the deliveries in the different APGAR-, pH groups (%) during the defined corridors of the 'Hand Over Times' (HOT) and 'no HOT'. The distribution to be expected, assuming equal distribution, is marked. During the HOT of professionals, APGAR values below 7 and pH values below 7.15 were less often found.

pH values: The pH subgroup analysis showed more deliveries during 'no HOT' with a pH <7.15 (Figure 3). In the comparison between 'no HOT' and 'HOT' of the midwives significantly fewer deliveries with a pH value of 7.10-7.15 as well as >7.20 were recorded.

APGAR scores: The ratio-analysis showed fewer deliveries as expected during the HOT of the midwives and the doctors in all APGAR groups <8 (Figure 3). Though not statistically significant the next step of our analysis showed significantly fewer deliveries during the HOT of both professional groups in the subgroup APGAR score 6-7 ($p<0.001$). In comparison between 'no HOT' and 'HOT' of the midwives significant fewer deliveries with an APGAR score 6-7 were recorded.

DISCUSSION

This study aimed to examine whether the neonatal outcome is influenced by different times of day, day-, nighttime, different weekdays, and work-related HOT. Few studies have already been conducted to correlate the time of birth with the outcome of the neonates [11-19]. Our study contributes with a large number of deliveries and a long period to the ongoing discussion about the working environment. The results show the excellent standard of care provided in a tertiary hospital 24/7/365.

Our results show an increase in deliveries at 9.30 am from Monday-Friday (Figure 1). So far, only a few studies confirm this finding with a higher percentage of deliveries during the morning hours [23]. From our point of view, this could be caused by the planned caesarean sections during the morning shift as well as more staff during weekday shifts and their focus on the progression of the birth.

Fewer births during the night time were shown. This is in line with the data of the National Center for Health Statistics in the

United States. They showed a higher percentage of deliveries during the day hours.

Relating to the lower birth rate on the weekend our study confirms the study of Roemer VM et al. [22]. In his study birth dates from almost 3 million babies born between 1969 and 2005 in Switzerland were analysed for the weekday of birth. The data presented corroborate and extend earlier findings on decreased birth rates on weekends [24]. This is in accordance with Gould et al., who published a decrease of 17,5% for deliveries on weekends [25]. The lower birth rates during the weekend could be due to a lower number of planned caesarean sections as well as a focus on low-risk deliveries on the weekend.

No significant difference in the neonatal outcome during the different weekdays, with respect to the threshold value, was recorded. This is in line with other studies, which have not detected a difference in the neonatal outcome for the different days [12-27]. Controversy exists regarding the risk of perinatal mortality and decreased staffing [17,19,28]. In detail, Palmer et al. showed that the perinatal mortality rate was 7.3 per 1000 babies delivered at weekends, 0.9 per 1000 higher than for weekdays [28]. Besides that, in Tanzania it was shown that off-hour deliveries were significantly associated with a higher proportion of adverse perinatal outcomes, including low Apgar score, early neonatal death, and fresh stillbirth, compared to morning and evening shifts [17].

The initial hypothesis during the off-hours, including the nighttime, was a reduction of medical care due to decreased staffing and increased physician fatigue, both of which may have an impact on the quality of care [29]. However, during the nighttime significant less low pH- and APGAR values were recorded (Figure 2). This is in contrast to Pasupathy et al., who published a higher rate of death out of hours due to an increased risk of death ascribed to intrapartum anoxia [21]. Our data demonstrate even fewer deliveries with a worse outcome during the nighttime and continuous high care. The basis may be even more careful obstetrics during the off-hours, due to the reduced staff. Our results confirm prior publications showing continuous high care independently of the time of birth [12,13,20,26]. Aiken et al. [20] examined the number of hours worked prior to birth and the maternal and neonatal outcome. They found no difference in the risk of any adverse outcome studied between day versus night shifts [20].

For the first time to our knowledge, the birth outcome during HOT was analyzed in this study. Interestingly the data showed a reduction of births during the HOT of the professionals (Table 2). This shows the focus on the HOT and a reduction of births, including a reduction of a bad neonatal outcome, during this time. The reason for significantly fewer births for the midwives could be due to the aim of 'finishing' birth in her shift and avoiding deliveries during their HOT. With long personal care, the midwives provide during labour this ensures the continuity of personal care. Doctors, on the other hand, have worked their routine shift and receive a hand over for the on-call in the afternoon. Here the midwives as primary caretakers have established a plan for the labour and continue to do so unless a change of circumstances demands reconsideration. As our

analysis is the first of its kind these results need to be verified by further studies and different settings.

Last but not least weaknesses of our study need to be addressed. Starting with the retrospective character of our analysis, possibility that HOT were changed daily due to the clinical workload of the doctors. This may happen more frequently for the doctoral HOTs as the participants are employed in the obstetrical and gynaecological department and take over the on-call after their routine work. This may include oncological surgery as well as i.e. IVF outpatient clinics. In a prospective study, this can be noted in more detail. On the other side, adverse outcomes in obstetrics happen only occasionally. Therefore, a retrospective analysis provides the number needed for such an analysis. Further, the data derive from a single large obstetrics center and may be biased by the expertise and strive for optimal care. In smaller hospitals with less staff or different on-call requirements, the outcome may be different. Therefore, our results may not be generalized to other settings. Though, due to legal regulations in Germany the on-call schedule as well as the staffing matches with many obstetric centers. The advantage of data from a single-center, however, is that working patterns are clearly defined and remain constant throughout the study period.

Besides that, the data could be biased by the university compared with smaller obstetric centers. In the university, the number of deliveries and the level of stress might be higher, which could influence the education level. These factors could lead on the one hand to a lower level of medical care due to more work and on the other hand to good expertise due to the high number of deliveries and more experiences.

Despite the changes of the working laws in recent years, we can exclude modifications of shift patterns/HOT by defining the end date. In the following years, the first modifications happened to the best of our knowledge a lengthy period.

Besides that, the neonatal outcome depends on various factors, and not only on the birth pH as well as the APGAR score. But those two factors are well established and have been recorded continuously without changes in the definition. There may be better or more accurate parameters, for example, the neonatal outcome after 24 hours as well as the transfer to the paediatric clinic, but these lack the length and number for such an analysis.

Our study can be seen as an internal audit for the obstetrical patient care during the different times of birth, but rises important-even political-questions. To answer these extended multicentric evaluations is needed. So far, this study highlights that this hospital is a reliable unit providing the expected interdisciplinary care 24/7/365. However, to meet the rising demand in the obstetrics, including the increasing birth rates as well as the centralisation of obstetric centers, this needs to be re-evaluated continuously.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

ETHICAL APPROVAL

The study protocol was submitted to and approved by the ethics committee of the University of Ulm.

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None.

REFERENCES

- Acton J, Tucker PE, Bulsara MK, Cohen PA. Working hours of obstetrics and gynecology trainees in Australia and New Zealand. *Aust N Z J Obstet Gynaecol.* 2017;57:508-513.
- Friedman RC, Kornfeld DS, Bigger TJ. Psychological problems associated with sleep deprivation in interns. *J Med Educ.* 1973;48:436-441.
- Dinges DF, Pack F, Williams K, Gillen KA, Powell JW, Ott GE, et al. Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep.* Oxford University Press. 1997;20:267-277.
- Gabehart RJ, Van Dongen HPA. circadian rhythms in sleepiness, alertness, and performance. in: principles and practice of sleep medicine. Elsevier; 2017:388-395.e5.
- Leach DC. Residents work hours: the Achilles heel of the profession? *Acad Med.* 2000;75:1156-1157.
- Dawson D, Reid K. Fatigue, alcohol and performance impairment. *Nature.* Nature Publishing Group. 17;388:235-255.
- Cram P, Hillis SL, Barnett M, Rosenthal GE. Effects of weekend admission and hospital teaching status on in-hospital mortality. *Am J Med.* 2004;117:151-157.
- Aylin P, Yunus A, Bottle A, Majeed A, Bell D. Weekend mortality for emergency admissions. A large, multicentre study. *Qual Saf Health Care.* 2010;19:213-217.
- Bailit JL, Landon MB, Thom E, Rouse DJ, Spong CY, Varner MW, et al. The MFMU Cesarean Registry: impact of time of day on cesarean complications. *Am J Obstet Gyne.* 2006;195:1132-1137.
- Chalmers JW, Shanks E, Paterson S, McInnery K, Baird D, Penney G, et al. Scottish data on intrapartum related deaths are in same direction as Welsh data. *BMJ.* 1998;317:539-540.
- Tavares S, Cavaco-Gomes J, Moucho M, Severo M, Mateus M, Ramalho C, et al. 24/7 presence of medical staff in the labor ward; no day-night differences in perinatal and maternal outcomes. *Am J Perinatol.* 2017;34:529-534.
- Caughey AB, Urato AC, Lee KA, Thiet MP, Washington AE, Laros RK Jr, et al. Time of delivery and neonatal morbidity and mortality. *Obstetric Anesthesia Digest.* 2009;29:89-90.
- Frank-Wolf M, Tovbin J, Wiener Y, Neeman O, Kurzweil Y, Maymon R, et al. Is there a correlation between time of delivery and newborn cord pH? *J Matern Fetal Neonatal Med.* 2017;30:1637-1640.
- Lyndon A, Lee HC, Gay C, Gilbert WM, Gould JB, Lee KA, et al. Effect of time of birth on maternal morbidity during childbirth hospitalization in California. *Am J Obstet Gyne.* 2015;213:705.e1-e11.
- Gijzen R, Hukkelhoven CW, Schipper CMA, Ogbu UC, de Bruin-Kooistra M, Westert GP, et al. Effects of hospital delivery during off-hours on perinatal outcome in several subgroups: a retrospective cohort study. *BMC Pregnancy and Childbirth.* Bio Med Central. 2012;12:1632.
- Stockman JA. Time of birth and risk of neonatal death at term: retrospective cohort study. *Yearbook of Pediatrics.* 2012;2012:397-399.
- Mgaya A, Hinju J, Kidanto H. Is time of birth a predictor of adverse perinatal outcome? A hospital-based cross-sectional study in a low-resource setting, Tanzania. *BMC Pregnancy and Childbirth.* 2017;17:184.
- Wu YW, Pham TN, Danielsen B, Towner D, Smith L, Johnston SC, et al. Nighttime delivery and risk of neonatal encephalopathy. *Am J Obstet Gyne.* 2011;204:e1-e6.
- Nam JY, Lee SG, Nam CM, Park S, Jang SI, Park EC, et al. The effect of off-hour delivery on severe maternal morbidity: a population-based cohort study. *Eur J Public Health.* 2019;18:387-462.
- Aiken CE, Aiken AR, Scott JG, Brockelsby JC. The influence of hours worked prior to delivery on maternal and neonatal outcomes: a retrospective cohort study. *Am J Obstet Gynecol.* 2016;215:634.e1-634.e7.
- Pasupathy D, Wood AM, Pell JP, Fleming M, Smith GCS. Time of birth and risk of neonatal death at term: retrospective cohort study. *BMJ.* 2010;341:c3498-c3499.
- Roemer VM, Beyer B. Outcome measures in perinatal medicine-pH or BE. The thresholds of these parameters in term infants. *Z Geburtshilfe Neonatol.* Georg Thieme Verlag Stuttgart New York. 212;4:136-146.
- National Center for Health Statistics. When are babies born: morning, noon, or night? *Birth Certificate Data for 2013.* 2015:1-9.
- Lerchl A, Reinhard SC. Where are the Sunday babies? II. Declining weekend birth rates in Switzerland. *Naturwissenschaften.* Springer-Verlag. 2008;95:161-164.
- Gould JB, Qin C, Marks AR, Chavez G. Neonatal mortality in weekend vs weekday births. *JAMA.* Am Med Asso. 2003;289:2958-2962.
- Ricci WM, Gallagher B, Brandt A, Schwappach J, Tucker M, Leighton R. Is after-hours orthopaedic surgery associated with adverse outcomes? A prospective comparative study. *J Bone Joint Surg Am.* 2009;91:2067-2072.
- Gijzen R, Hukkelhoven CW, Schipper CMA, Ogbu UC, de Bruin-Kooistra M, Westert GP, et al. Effects of hospital delivery during off-hours on perinatal outcome in several subgroups: a retrospective cohort study. *BMC Pregnancy and Childbirth.* BioMed Central. 2012;12:1632.
- Palmer WL, Bottle A, Aylin P. Association between day of delivery and obstetric outcomes: observational study. *BMJ.* 2015;4:5774-5777.
- Van Zaane B, Van Klei WA, Buhre WF, Bauer P, Boerma EC, Hoelt A, et al. Nonelective surgery at night and in-hospital mortality: Prospective observational data from the European Surgical Outcomes Study. *Eur J Anaesthesiol.* 2015;32:477-85.