ORIGINAL PAPER

International Journal of Occupational Medicine and Environmental Health 2023;36(1)
https://doi.org/10.13075/ijomeh.1896.01953

SELECTED ENVIRONMENTAL FACTORS IN MOTHERS OF NEWBORNS SUBJECTED TO THE THERAPEUTIC HYPOTHERMIA – A CASE CONTROL STUDY

EDYTA BARNAŚ[1], IRYNA BASIUHA[2], ELŻBIETA PORADA[3], MAREK SOBOLEWSKI[4], JOANNA SKRĘT-MAGIERŁO[5], and LYUDMYLA PAKHARENKO[2]

[1] University of Rzeszów, Rzeszów, Poland
Medical College of Rzeszów, Institute of Health Sciences
[2] Ivano-Frankivsk National Medical University, Ivano-Frankivsk, Ukraine
Department of Obstetrics and Gynecology
[3] Frederic Chopin Provincial Clinical Hospital No. 1, Rzeszów, Poland
Department of Obstetrics and Gynecology
[4] Rzeszów University of Technology, Rzeszów, Poland
Faculty of Management
[5] University of Rzeszów, Rzeszów, Poland
Medical College of Rzeszów, Institute of Medical Sciences

Abstract
Objectives: Hypothermia is an established method of treating severe forms of perinatal hypoxia in newborns. Some of them develop neonatal encephalopathy, which is associated with high morbidity and mortality. Therefore, prophylaxis of this pathology is important as well as determining environmental factors in mothers of newborns affected by this pathology. The aim of the study was to assess of selected environmental factors in mothers of newborns qualified for hypothermia. **Material and Methods:** The material consisted of 102 subjects, including 51 mothers of newborns with hypoxic-ischemic encephalopathy referred for hypothermia treatment (group I) and 51 mothers of newborns without signs of hypoxia (group II). The case-control study was carried out in the third level reference centre. It is 1 of 20 centers of therapeutic hypothermia for newborn in Poland. Data was collected based on a data collection sheet. Study groups were compared in terms of demographic and environmental data. The odds ratio (OR) was determined and the logistic regression analysis of univariate and multivariate regression was used to determine the probability of the need for hypothermia in the study group. **Results:** The groups did not differ in terms of age, BMI and place of living. The need to use hypothermia increased in pregnant women living together with their parents (OR = 6.8, 95% CI: 2.4–19.6) also in case of exposure to factors at the workplace, i.e., noise (OR = 4.1, 95% CI: 1.1–15.5). **Conclusions:** Based on the results of our case-control study we postulate to pay attention during preconception care to proper preparation for pregnancy especially in younger women exposed to nuisance in the work environment and at home. In this area postulated activities should include education programs, in close cooperation occupational medicine practitioners and obstetricians even before the conception as a part of pre-conception counseling. Int J Occup Med Environ Health. 2023;36(1)

Key words:
factors, environmental, woman, newborns, therapeutic hypothermia, pregnant

Received: December 3, 2021. Accepted: July 28, 2022.
Corresponding author: Edyta Barnaś, University of Rzeszów, Medical College of Rzeszów, Institute of Health Sciences, Rejtana 16c, 35-959 Rzeszów, Poland (e-mail: ebarnas@interia.eu).

INTRODUCTION

Maternal socio-economic conditions of affect a developing fetus. These conditions also determine the quality of prenatal healthcare. Poverty and low level of education has been found to predispose to numerous abnormalities increasing perinatal mortality and morbidity [1]. Socio-economic conditions are considered as the set of circumstances determining the intrauterine development of the fetus in perinatal medicine. According to Kurjak et al. [2] they include: demographic characteristics of parents, environmental conditions, living conditions, working conditions, income, nutrition, medical antenatal care, parents' addictions.

So far, numerous studies have been published on environmental factors influencing the genesis of neonatal encephalopathy (NE). A wide population of newborns diagnosed with perinatal asphyxia were investigated, however, a group subjected to therapeutic hypothermia was not distinguished [3–8].

Other studies included a narrow group of cases where hypoxic-ischemic encephalopathy (HIE) damage to tissues and organs occurred [9,10]. Hypoxic-ischemic encephalopathy is a major predictor of later neurodevelopmental disability, causing negative neonatal outcome in 15–20% of cases [11,12] and cerebral palsy in 25% [13]. Noteworthy, the term HIE is not synonymous with NE, although therapeutic management with hypothermia is the same. The causes of NE include: HIE, perinatal infections, placental abnormalities, metabolic disorders, coagulopathies and neonatal vascular stroke [14,15]. Neonatal encephalopathy incidence is estimated at 3.0/1000 live births (95% CI: 2.7–3.3) and 1.5 for HIE (95% CI: 1.3–1.7) [13].

The influence of factors related to the maternal and fetal health status on the incidence of NE was assessed retrospectively in the available literature. Generally, these factors can be divided into antenatal and intrapartum. Antenatal factors are commonly classified as poor socioeconomic conditions and pathologies related to the health of the mother and the fetus [9,16–18]. The following intrapartum factors were assessed: uterine contractions, general complications such as: sudden maternal hypotension, cardiorespiratory arrest and respiratory or circulatory disorders, obstetric intra-labor factors: umbilical cord prolapse, shoulder dystonia and retention of the after coming head, major placental abruption, uterine rupture and fetal-maternal haemorrhage [19–22].

Aim

Assess selected maternal environmental factors of newborns with hypoxic-ischemic encephalopathy referred to hypothermia treatment.

MATERIAL AND METHODS

The material of the case-control study was collected based on the analysis of medical records and an interview on the course of pregnancy and labour and clinical data of treated newborns.

The study group consisted of 51 patients whose neonates with diagnosed HIE were referred to hypothermia therapy. The newborns were transported to a third-line center for the purpose of implementing hypothermia treatment from the centers with a lower reference degree immediately after delivery for up to 6 h.

The indicators of neonatal hypoxia after birth are: Apgar score after 5 min of life <5 pts; umbilical cord blood pH of <7.0; BE alkalines deficiency >–12 mmol/l. Neurological disorders (convulsions, coma, decreased muscle tone) and multi-organ failure may occur in its aggravated forms [23].

Based on the results of their first measurements, perinatal hypoxia was diagnosed in the newborns transported to the center where qualification for hypothermia treatment was performed (Table 1).

The criteria of pre-qualification for hypothermia treatment included: gestational age of ≥36 weeks and confirmed at least 1 of the criteria listed in Table 2. An ad-

Table 1. The basic measurements of newborns (N = 51) on admission to a third-level reference facility (the newborns were transported from the Podkarpackie centers with a lower reference degree immediately after delivery for up to 6 h) – study carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016

Parameter	M±SD	Me	Min.	Max
pH first result	6.9±0.1	6.9	6.6	7.1
BE	−18.6±2.9	−18.0	−27.2	−13.2
Blood pressure (RR) (M)	43.7±12.1	43	20	74
Core temperature*	33.9±0.9	34.0	30.0	35.4
PO_2	47.9±27.6	36.5	11.0	100.0
PCO_2	65.1±23.4	66.9	23.0	119.0
HCO_3	5.2±11.2	10.0	−14.0	24.0
Saturation during transport	89.7±6.3	90.0	70.0	100.0

* The first measurement on admission to the ward.

ditional condition was the time between childbirth and hypothermia below 6 h.

Final assessment before qualification for hypothermia was performed in the hypothermia treatment center based on the above-mentioned criteria and a 20-minute a EEG recording by means of the Brain Function Monitor method. The *Sarnat and Sarnat* scale was used to assess NE staging [24].

The control group was composed of 51 postpartum women, these were the subsequent patients who gave birth to a healthy neonate, whose hospitalization was uneventful (discharged on day 2 or 3 after birth) (group II).

The study was carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016. The study was approved by the Bioethics Committee at the University of Rzeszów (resolution No. 02/04/2012). All surveyed women gave informed written consent to refer their child to hypothermia treatment (group I) and gave informed written consent to participate in the research project (group I and II).

The study focused on selected environmental factors which included the place of residence (e.g. rural/city, income, number of rooms, number of people, flat area, living with parents or with in-laws, a large family) and factors that determine working conditions (e.g. noise, cold, damp or dust at work, high temperature, toxic substances, nervousness, contact with toxic substances or ionizing radiation).

The collected data was developed with the Statistica v. 10.0 software. Statistical analysis included descriptive statistics

Table 2. Initial criteria qualifying for hypothermia in newborn with gestational age of ≥36 weeks [36–38] – study carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016

Stage	Hypothermia criteria
Stage I	the presence of one of the following symptoms – ≤5 Apgar score in the 10th minute of life – the need for mechanical ventilation (via an endotracheal tube/a bag valve mask/Neo-puff device) 10 min after birth – acidosis: pH <7.0 in umbilical cord or arterial blood 1 h after birth and/or an alkaline deficiency of at least 16 mmol/l (BE ≤−16 mmol/l) in umbilical cord blood or any blood sample (arterial, capillary or venous) at first hour after birth
Stage II	the presence of one of the following symptoms – lethargy, numbness, coma – reduced muscle tone – abnormal reactions to stimuli – lack or decreased sucking reflex – seizures, spasms, increased muscle tone

(mean (M) ± standard deviation (SD)) as well as the odds ratio (along with the 95% confidence interval (CI)) and the test probability p calculated using the logistic regression analysis carried out for each of the independent factors separately. In addition, a multivariate logistic regression model was used to model the probability of requiring therapeutic hypothermia. Several factors related to demographic data, environmental conditions, working conditions and health behavior in pregnancy were introduced as potential independent variables into the multivariate model. The optimal model was developed using the forward stepwise regression procedure.

RESULTS

It has been shown that as the mother grows older, the chance of requiring therapeutic hypothermia in the newborn decreases. With each maternal year, the chance of having to apply hypothermia in the neonate decreased by approx. 10.7% (Table 3).

It was found that the incidence of therapeutic hypothermia in the neonate was related to the number of people living in the same household (OR = 1.5, p = 0.0083) and to the fact that the child's mother lived with her parents (OR = 4.8, p = 0.0025). In practice, it was most frequently associated with more difficult living conditions. Interestingly, the risk decreased if the respondent was provided with help with domestic activities (OR = 0.2, p = 0.0030). Among working conditions, 2 factors significantly affected the risk of a baby's health condition after delivery, which would require therapeutic hypothermia. One of these factors was noise (OR = 5.3, p = 0.0052), while the other was cold, damp or dust at work (OR = 4.4, p = 0.0094) (Table 4).

The applied multivariate logistic regression model allowed to identify 3 statistically significant factors ($p < 0.05$). The risk of hypothermia increased in the case of living with parents or in-laws (OR = 6.8, p = 0.0003), insufficient stay outdoors during pregnancy (OR = 0.7, p = 0.0204, i.e., every hour longer means a decrease in the chance of hypothermia by 28%) and noise (OR = 4.1, p = 0.0338) or other nuisance factors at workplace (OR = 4.0, p = 0.0633) (Table 5).

In turn, Table 6 presents the quality assessment of such classification for the model described in Table 5. The cut-off criterion in the diagnostic test constructed on the basis of the logistic regression model was the probability of hypothermia >50%. Both indices (sensitivity and specificity) were found to be at an average level – slightly >70% in the test based on the logistic regression model (Table 6).

Table 3. Demographic data of the study group – study carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016

Variable	Participants (N = 102) (M±SD)		OR (95% CI)*	p
	group I (N = 51)	group II (N = 51)		
Age [years]	28.4±5.0	31.3±5.2	0.893 (0.823–0.968)	0.0062
Height [cm]	162.3±5.7	164.1±5.9	0.944 (0.881–1.012)	0.1043
Body mass [kg]	61.8±12.5	63.0±9.9	0.990 (0.955–1.026)	0.5745
BMI	23.4±4.2	23.4±3.2	1.003 (0.902–1.115)	0.9594
Education [years]	12.8±2.9	13.7±2.7	0.891(0.769–1.032)	0.1237

* These values were calculated using the logistic regression analysis performed for each of the independent factors separately.

Table 4. Selected environmental factors concerning the place of residence and working conditions – results of univariate analysis (separately for each factor) – study carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016

Variable	Participants (N = 102)		OR (95% CI)*	p
	group I (N = 51)	group II (N = 51)		
Place of residence				
living in the rural area [n (%)]	25 (49.0)	23 (45.1)	1.171 (0.538–2.549)	0.6916
income >PLN 1000 [n (%)]	16 (31.4)	23 (45.1)	0.557 (0.248–1.249)	0.1555
rooms [n] (M±SD)	4.9±1.7	4.9±1.2	1.000 (0.765–1.307)	1.0000
people [n] (M±SD)	4.4±1.5	3.6±1.3	1.507 (1.112–2.044)	0.0083
flat area [m^2] (M±SD)	111.5±46.0	105.5±44.1	1.003 (0.994–1.012)	0.4961
good living conditions [n (%)]	41 (80.4)	33 (64.7)	2.236 (0.910–5.493)	0.0792
living with parents [n (%)]	20 (39.2)	6 (11.8)	4.839 (1.744–13.427)	0.0025
living with in-laws [n (%)]	6 (11.8)	3 (5.9)	2.133 (0.503–9.043)	0.3039
a large family [n (%)]	14 (27.5)	10 (19.6)	1.551 (0.615–3.913)	0.3523
being helped with household chores [n (%)]	23 (45.1)	38 (74.5)	0.281 (0.122–0.649)	0.0030
Nuisance working conditions [n (%)]				
noise	16 (31.4)	4(7.8)	5.371 (1.651–17.477)	0.0052
cold, damp or dust at work	14 (27.5)	4 (7.8)	4.45 (1.35–14.64)	0.0094
high temperature	5 (9.8)	8 (15.7)	0.584 (0.177–1.925)	0.3769
toxic substances	2 (3.9)	3 (5.9)	0.653 (0.104–4.083)	0.6487
nervousness	14 (27.5)	23 (45.1)	0.461 (0.202–1.052)	0.0659
contact with toxic substances	3 (5.9)	4 (7.8)	0.734 (0.156–3.460)	0.6963
contact with ionizing radiation	1 (2.0)	1 (2.0)	1.000 (0.061–16.435)	1.0000
any	23 (45.1)	17 (33.3)	1.643 (0.737–3.663)	0.2250

* These values were calculated using the logistic regression analysis performed for each of the independent factors separately.

DISCUSSION

Factors related to NE pathologies have been investigated in the literature for many years. Negative outcomes of NE in the form of morbidity and mortality require a multifaceted approach that will allow for optimal care planning not only during pregnancy but even before conception in order to eliminate factors that may be related to NE.

One of the first reports that draws attention to the complexity of NE etiology and in conclusion postulating a careful selection of prenatal factors, was a control-case study conducted in the 1990s in Western Australia. In the group of 164 newborns hospitalized due to moderate or severe neonatal encephalopathy socioeconomic status, family history of seizures, neurological problems and conception after fertility treatment were all independent preconception risk factors for NE. However, selectively analyzed environmental factors, e.g. regarding the mother's age, do not correlate with our results. The authors demonstrated that the risk of encephalopathy increases with the mother's age, it is worth noting that therapeutic hypothermia was not used in this study [17].

The results obtained by Anggondowati et al. [25] from Indonesia, clearly indicate the correlation of environmental

Table 5. Multivariate logistic regression model – study carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016

Factor	Hypothermia probability	
	OR (95% CI)*	p
Living with parents or in-laws	6.89 (2.415–19.631)	0.0003
Noise	4.16 (1.116–15.515)	0.0338
Cold, damp, dust	4.00 (0.926–17.292)	0.0633

* These values were calculated using the logistic regression analysis performed for each of the independent factors separately.

Table 6. Classification of cases made on the basis of a logistic regression model with measures of the quality of the diagnostic test – study carried out in the Clinical Department of Obstetrics and in the Department of Neonatology with Neonatal Intensive Care Unit of Frederic Chopin Provincial Clinical Hospital No. 1 in Rzeszów, Poland, in 2012–2016

Classification based on a logistic regression model	Observed condition (N = 102) [n]	
	group I (N = 51, TPR 71%)	group II (N = 51, TNR 73%)
Group I (N = 50, PPV 72%)	36	14
Group II (N = 52, NPV 71%)	15	37

NPV – negative predictive value; PPV – positive predictive value; TNR – true negative rate (specificity); TPR – true positive rate (sensitivity).

factors, i.e., the young maternal age, living in the rural area, long distance from the hospital, poverty, low level of maternal education, unemployment as having adverse impact on delivery results. In terms of maternal factors related to the occurrence of neonatal asphyxia, Anggondowati et al. noted in the group of 357 examined newborns a 5-fold increase incidence of living in the rural residence (<0.001) (AOR = 5.3, 95% CI: 1.9–18.1) [25]. Our study did not show that the place of residence, city/village, is related to the occurrence of NE and the need for hypothermia treatment. The unequivalence of the results can be explained by the discrepancies in living conditions in the countryside between Poland and Indonesia.

The need to use hypothermia increased in pregnant women living together with their parents OR = 6.8, 95% CI: 2.4–19.6. Therefore, it was practically associated with more difficult living conditions, which may be associated with the low economic status identified in the literature. One of the consequences of insufficient socio-material conditions is poorer access to maternity care both before and during pregnancy, regardless of the level of economic development of the country. The factor related to the low quality of prenatal care, often provided at the level of primary health care, or the lack of preparation for childbirth, translates into a significantly higher frequency of diagnoses of "asphyxia" during childbirth [4,6,9,26].

Additionally, noteworthy is the access to free medical care, both before and during pregnancy in Poland. However, this fact is not tantamount to the optimal, conscious preparation of a woman and her partner for parenthood. Despite free care available, perinatal indicators, e.g., the percentage of premature births in Poland have not changed for many years, and as a result, the frequency of premature births is constant and amounts to approx. 7% per year [27]. Thus, other factors related to the mother's life situation, nuisance related to living or workplace conditions are often of significant importance in this respect. Hence the problem of sickness absenteeism of pregnant women observed in practice [28]. A large Polish cohort study analyzing the economic activity of pregnant women clearly indicates the group of women with lower education and a worse economic status, as the group most often discontinuing their current professional activity [29]. The own study did not show any differences in the level of education among the respondents, which may be due to the small size of the groups. On the other hand, it is worth noting that declaring any nuisance related to the workplace (including noise, temperature, stress) resulted in excluding the pregnant woman from her current position. It is compliant with the legal regulations in force [30,31]. As shown by the analysis of the literature,

in the event of a nuisance or a harmful factor, excluding from the current job position is very often associated with the cessation of professional activity of pregnant women [29,32]. On the one hand, it is purely a matter of the concern for the safety of pregnancy, on the other hand, the lack of precise information about the patient's working conditions, and thus a selective assessment of the potential risk of pregnancy complications by the attending gynecologist. Hence, in this aspect, close cooperation between a gynecologist and an occupational medicine physician is required to optimize the care of a professionally active pregnant woman [29,32]. Taking into account the results of our study, it is postulated that this cooperation should cover an earlier period, i.e., the inclusion of an occupational medicine physician in services under pre-contraceptive consultation.

In the context of our study, maternal age is an important risk factor for hypoxia. Parker et al. [26] showed that if sentinel events were taken out then maternal age >35 years (RR = 2.5, 95% CI: 1.1–5.6) was a risk factor. The higher the mother's age, the higher the risk of NE [4,6,9,17,25]. Interestingly, our study showed a slightly different trend, indicating that with the mother's age, the chance of requiring hypothermia in the child decreased. With each year of the maternal age, it decreased by about 19.7%. Hence, there is a need to pay attention to younger women in the context of planned and provided pregnancy care. A similar result concerning younger women with a lower financial status was indicated by Anggondowati et al. [25] and Nelson et al. [16] where the risk of using hypothermia was >3 times higher in the group of maternal age ≤15 years old .

Analyzing a narrow group of newborns with HIE with an umbilical pH <7.00 (regardless of the Sarnat classification), Barrois et al. [33] drew attention to the fact that the incidence of HIE was more often observed in the group of overweight mothers (25.0% vs. 13.6%, and OR = 15.5, 95% CI: 1.1–12.5 with comorbidities complicating the course of pregnancy [33]. Liljestorm et al. [18] came to similar conclusions, they observed that women of short stature with higher body weight had increased risk of HIE (OR = 3.66, 95% CI: 2.4–5.5). In an Italian study, Locatelli et al. [34] found a higher risk for HIE if the mother was obese. The study from Texas also indicates a relationship between high maternal BMI ≥40 kg/m^2 with the diagnosis of HIE and the necessity to use hypothermia in the newborn [16]. Also, a large retrospective study from Sweden, based on a cohort of 36 086 women, showed that the antenatal factor associated with a higher risk of HIE was overweight (BMI M±SD 25.9±4.4 vs. 25.1±4.8, p = 0.047) [35]. Peebles et al. [36] reported interesting findings drawing attention to the important fact of weight gain in pregnancy. Based on a large retrospective cohort study from the USA (N = 25 494), they showed that weight gain in pregnancy >13.6 kg was associated with a 2-fold higher risk of HIE in the newborn (OR = 2.28, 95% CI: 1.07–4.86) [36]. In our study, there were no overweight women and women with abnormal weight gain during pregnancy.

Limitations

Performed analysis was narrow, not taking into account all environmental factors, especially those closely related to the workplace itself. When analyzing work-related factors, no detailed analysis of the nuisance or exposure to harmful factors present at the current workplace was made. All respondents were excluded from performing work in the current position, however, the study did not analyze in detail how many women were transferred to perform another job and how many were released from the obligation to perform work. Moreover, the analysis in terms of exposure to nuisance at home, while performing daily duties, has not been deepened. This limitation clearly indicates the need for closer cooperation between the occupational medicine doctor and the obstetrician-gynecologist, it is postulated that this cooperation should already cover the scope of preconception counselling. In the context of the severity and

significance of the disease itself, it is extremely important to plan multi-center studies in the future.

Strengths of the study

The study is pioneering in the analysis of maternal environmental factors. Knowing these risk factors for hypothermia may result in a rational choice of delivery place where is possible therapeutic hypothermia direct after birth. This in turn may limit transfers to hospital with hypothermic center which can take up to maximum 6 hours if baby meets the criteria for therapeutic hypothermia.

CONCLUSIONS

Several studies provided general evidence that applying legal provisions on prohibited work during pregnancy and taking into account working conditions that are optimal for a developing fetus are important for reaching healthy pregnancy outcomes. Considering the severity and long-term effects of the disease described: hypoxic-ischemic encephalopathy, the aspect of identifying risk factors before pregnancy that may be related to this serious disorder is an extremely important issue.

Based on the results of our case-control study we postulate to pay attention during preconception care to proper preparation for pregnancy especially in younger women exposed to nuisance in the work environment and at home. In this respect, postulated activities should include education programs, close cooperation of occupational medicine practitioners and obstetricians, even before the conception as a part of pre-conception counseling.

REFERENCES

1. Haider SJ. Racial and ethnic infant mortality gaps and socioeconomic status. Focus. 2014;31:18-20.
2. Kurjak A, Di Renzo GC, Stanojevic M. Globalization and perinatal medicine--how do we respond? J Matern Fetal Neonatal Med. 2010;23(4):286-96. https://doi.org/10.3109/14767050903105889.
3. Milsom I, Ladfors L, Thiringer K, Niklasson A, Odeback A, Thornberg E. Influence of maternal, obstetric and fetal risk factors on the prevalence of birth asphyxia at term in a Swedish urban population. Acta Obstet Gynecol Scand. 2002; 81(10):909-17. https://doi.org/10.1034/j.1600-0412.2002.811003.x.
4. Berglund S, Grunewald C, Pettersson H, Cnattingius S. Risk factors for asphyxia associated with substandard care during labor. Acta Obstet Gynecol Scand. 2010;89(1):39-48. https://doi.org/10.3109/00016340903418751.
5. Torres-Muñoz J, Rojas C, Mendoza-Urbano D, Marín-Cuero D, Orobio S, Echandía C. Risk factors associated with the development of perinatal asphyxia in neonates at the Hospital
6. Universitario del Valle, Cali, Colombia, 2010-2011. Biomedica. 2017;37(0):51-56. https://doi.org/10.7705/biomedica.v37i1.2844. Spanish
7. Chiabi A, Nguefack S, Mah E, Nodem S, Mbuagbaw L, Mbonda E, et al. Risk factors for birth asphyxia in an urban health facility in cameroon. Iran J Child Neurol. 2013;7(3): 46-54.
8. Ogunlesi TA, Fetuga MB, Adekanmbi AF. Mothers' knowledge about birth asphyxia: the need to do more! Niger J Clin Pract. 2013;16(1):31-6. https://doi.org/10.4103/1119-3077.106726.
9. Nayeri F, Shariat M, Dalili H, Bani Adam L, Zareh Mehrjerdi F, Shakeri A. Perinatal risk factors for neonatal asphyxia in Vali-e-Asr hospital, Tehran-Iran. Iran J Reprod Med. 2012;10(2):137-40.
10. Futrakul S, Praisuwanna P, Thaitumyanon P. Risk Factors for Hypoxic-Ischemic Encephalopathy in Asphyxiated Newborn Infants. J Med Assoc Thai 2006;89(3):322-8.
11. Fredricks TR, Gibson C Oms, Essien F Oms, Benseler JS. Therapeutic Hypothermia to Treat a Newborn With Perinatal Hypoxic-Ischemic Encephalopathy. J Am Osteopath Assoc. 2017;117(6):393-398. https://doi.org/10.7556/jaoa.2017.078.
12. Hayes BC, Doherty E, Grehan A, Madigan C, McGarvey C, Mulvany S, et al. Neurodevelopmental outcome in survivors

of hypoxic ischemic encephalopathy without cerebral palsy. Eur J Pediatr. 2018;177(1):19-32. https://doi.org/10.1007/s00431-017-3028-3.

13. Odd D, Heep A, Luyt K, Draycott T. Hypoxic-ischemic brain injury: Planned delivery before intrapartum events. J Neonatal Perinatal Med. 2017;10(4),347-353. https://doi.org/10.3233/NPM-16152.
14. Kurinczuk JJ, White-Koning M, Badawi N. Epidemiology of neonatal encephalopathy and hypoxic-ischaemic encephalopathy. Early Hum Dev. 2010;86(6):329-38. https://doi.org/10.1016/j.earlhumdev.2010.05.010.
15. Aslam S, Strickland T, Molloy EJ. Neonatal Encephalopathy: Need for Recognition of Multiple Etiologies for Optimal Management. Front Pediatr. 2019;16(7):142. https://doi.org/10.3389/fped.2019.00142.
16. Hayakawa M, Ito Y, Saito S, Mitsuda N, Hosono S, Yoda H, et al. Executive Committee, Symposium on Japan Society of Perinatal and Neonatal Medicine. Incidence and prediction of outcome in hypoxic-ischemic encephalopathy in Japan. Pediatr Int. 2014;56(2):215-21. https://doi.org/10.1111/ped.12233.
17. Nelson KB. Is it HIE? And why that matters. Acta Paediatrica. 2007;96(8):1113-1114. https://doi.org/10.1111/j.1651-2227.2007.00364.x.
18. Badawi N, Kurinczuk JJ, Keogh JM, Alessandri LM, O'Sullivan F, Burton PR, et al. Antepartum risk factors for newborn encephalopathy: the Western Australian case-control study. BMJ. 19985;317(7172):1549-53. https://doi.org/10.1136/bmj.317.7172.1549.
19. Liljestrom L, Wikstrom AK, Agren J, Jonsson M. Antepartum risk factors for moderate to severe neonatal hypoxic ischemic encephalopathy: a Swedish national cohort study. Acta Obstet Gynecol Scand. 2018;97(5):615-623. https://doi.org/10.1111/aogs.13316.
20. Rei M, Ayres-de-Campos D, Bernardes J. Neurological damage arising from intrapartum hypoxia/acidosis. Best Pract Res Clin Obstet Gynaecol. 2016;30:79-86. https://doi.org/10.1016/j.bpobgyn.2015.04.011.
21. Martinez-Biarge M, Cheong JL, Diez-Sebastian J, Mercuri E, Dubowitz LM, Cowan FM. Risk Factors for Neonatal Arterial Ischemic Stroke: The Importance of the Intrapartum Period. J Pediatr. 2016;173:62-68.e1. https://doi.org/10.1016/j.jpeds.2016.02.064.
22. Torbenson VE, Tolcher MC, Nesbitt KM, Colby CE, El-Nashar SA, Gostout BS, et al.Intrapartum factors associated with neonatal hypoxic ischemic encephalopathy: a case-controlled study. BMC Pregnancy Childbirth. 201711;17(1):415. https://doi.org/10.1186/s12884-017-1610-3.
23. Glass HC. Hypoxic-Ischemic Encephalopathy and Other Neonatal Encephalopathies. Continuum (Minneap Minn). 2018;24(1):57-71. https://doi.org/10.1212/CON.0000000000000557.
24. Task Force on Neonataly Encephalopathy; D'Alton ME, Hankins GDV, Berkowitz RL, Bienstock J, Ghidini A, et al. Executive summary: Neonatal encephalopathy and neurologic outcome, second edition. Report of the American College of Obstetricians and Gynecologists' Task Force on Neonatal Encephalopathy. Obstet Gynecol 2014;123:896-901.
25. Sarnat HB, Sarnat MS. Neonatal encephalopathy following fetal distress: a clinical and electrographic study. Arch Neurol. 1976;33(10):696-705
26. Anggondowati T, El-Mohandes AA, Qomariyah SN, Kiely M, Ryon JJ, Gipson RF, et al.Maternal characteristics and obstetrical complications impact neonatal outcomes in Indonesia: a prospective study. BMC Pregnancy Childbirth. 201728;17(1):100. https://doi.org/10.1186/s12884-017-1280-1.
27. Parker SJ, Kuzniewicz M, Niki H, Wu YW. Antenatal and intrapartum risk factors for hypoxic-ischemic encephalopathy in a US birth cohort. J Pediatr. 2018, 203:163–9. https://doi.org/10.1016/j.jpeds.2018.08.028.
28. Di Renzo GC,Cabero Roura L, Facchinetti F, Helmer H,Hubinont C, Jacobsson C, et al. Preterm Labor and Birth Management: Recommendations from the European Association of Perinatal Medicine. J Matern-Fetal Neonatal Med. 2017;30(17):2011-2030. https://doi.org/10.1080/14767058.2017.1323860.

29. Szubert Z. Sickness absence in poland after socio-economic transformation. Med Pr. 2014;65(1):73-84. https://doi.org/10.13075/mp.5893.2014.003. Polish.
30. Polańska K, Jurewicz J, Marcinkiewicz A, Makowiec-Dąbrowska T, Hanke W. Occupational activity during pregnancy based on the Polish mother and child cohort study. Med Pr. 2014;65(1):65-72. https://doi.org/10.13075/mp.5893.2014.004. Polish.
31. Ustawa z dnia 26 czerwca 1974 r. Kodeks pracy. (Dz. U. z 1998 r. nr 21, poz. 94 z późn. zm.)
32. Rozporządzenie Rady Ministrów z dnia 3 kwietnia 2017 r. w sprawie wykazu prac uciążliwych, niebezpiecznych lub szkodliwych dla zdrowia kobiet w ciąży i kobiet karmiących dziecko piersią (Dz. U. Z 2017 r., poz. 796)
33. Marcinkiewicz A, Wężyk A, Muszyński P, et al. Good practice in occupational health services – the influence of hazardous conditions and nuisance coexisting in the work environment and at home on the course and outcome of pregnancy. Med Pr. 2015;66(5):713-724. https://doi.org/10.13075/mp.5893.00201. Polish.
34. Barrois M, Patkai J, Delorme P, Chollat C, Goffinet F, Le Ray C. Factors associated with neonatal hypoxic ischemic encephalopathy in infants with an umbilical artery pH less than 7.00. Eur J Obstet Gynecol Reprod Biol. 2019;236:69-74. https://doi.org/10.1016/j.ejogrb.2019.02.009.
35. Locatelli A, Incerti M, Paterlini G, Doria V, Consonni S, Provero C, et al. Antepartum and intrapartum risk factors for neonatal encephalopathy at term. Am J Perinatol. 2010;27(8):649-54. https://doi.org/10.1055/s-0030-1249761.
36. Lundgren C, Brudin L, Wanby AS, Blomberg M. Ante- and intrapartum risk factors for neonatal hypoxic ischemic encephalopathy. J Matern Fetal Neonatal Med. 2018;31(12):1595-1601. https://doi.org/10.1080/14767058.2017.1321628.
37. Peebles PJ, Duello TM, Eickhoff JC, McAdams RM. Antenatal and intrapartum risk factors for neonatal hypoxic ischemic encephalopathy. J Perinatol. 2020;40(1):63-69. https://doi.org/10.1038/s41372-019-0531-6.
38. Gulczyńska E, Gadzinowski J, Nowiczewski M. Leczenie hipotermią noworodka z encefalopatią niedotlenieniowo-niedokrwienną. In: Bekiesińska-Figatowska M, Bokiniec R, Borszewska-Kornacka MK, et al. editors: Standardy opieki medycznej nad noworodkiem w Polsce. Wydawnictwo Media- Press, Warszawa 2015. p.158-163. Polish.
39. Rekomendacja nr 28/2013 Prezesa AOTM z dnia 25 lutego 2013 r [Internet] [cited 2021 Dec 16]. Available from: http://wwwold.aotm.gov.pl/assets/files/rada/rekomendacje_stanowiska/2013-SRP/R-02-2013-Hipotermia/RP_28_2013_Hipotermia.pdf. Polish.
40. Nowacka-Gotowiec M, Dunin-Wąsowicz D. Therapeutic hypothermia in hypoxic-ischemic encepalopathy of neonates (Zastosowanie hipotermii leczniczej w encefalopatii niedotlenieniowoniedokrwiennej noworodków). Neurol Dziec. 2012;21(43):11-17. Polish.