Analysis of birth rate, neonatal morbidity, and mortality during the COVID-19 pandemic and martial law in Ukraine


Abstract. Background. Ukraine is currently experiencing a rapid decline in fertility due to the COVID-19 pandemic and martial law. The purpose was to study birth rate fluctuations and changes in the structure of early neonatal morbidity and mortality at Kyiv City Maternity Hospital 6 during the COVID-19 pandemic and martial law and to compare the obtained findings with national statistical data. Materials and methods. A retrospective analysis and assessment of birth rate fluctuations, early neonatal morbidity, and mortality were carried out for 2020–2022 using both the health care industry statistics and the data obtained from Kyiv City Maternity Hospital 6. Results. Increased morbidity and high psycho-emotional stress levels among pregnant women contributed to a more frequent occurrence of neonatal disorders associated primarily with intrauterine hypoxia and perinatal infection. The improvements in newborn care and concurrent reduction in the preterm birth rate at the maternity hospital providing level II perinatal care services have been associated with a decreased rate of early neonatal mortality over the past three years. Conclusions. The use of modern fetal monitoring technologies, the timely diagnosis and treatment of perinatal pathology, and improvements in the organization of newborn care help preserve child health and prevent mortality. Keywords: COVID-19; newborns; morbidity; birth rate; mortality; martial law

Introduction

Over the past three years, the health care system of Ukraine, including obstetric and neonatal care facilities, has encountered serious challenges associated with an increased incidence of COVID-19 among the population and COVID-19 lockdown measures. The implementation of martial law caused widespread population migration, a gradual decline in the birth rate, ongoing psycho-emotional stress, etc., which exacerbated the situation [1, 2].

Pregnancy is one of the most critical periods in terms of morbidity and mortality due to physiological, endocrine, and immunological changes in a woman’s body [3, 4]. With the onset of pregnancy, both the development of immune tolerance and the activation of pro-inflammatory changes are observed simultaneously. The activity of specific immune cells decreases, and the immunological profile shifts from Th1 to predominantly Th2, while the level and activity of monocytes, dendritic cells, and polymorphonuclear cells increase. In general, pregnant women are not more susceptible to infectious diseases than non-pregnant women, but immunological changes can interfere with the body’s ability to combat certain pathogens, which can contribute to disease severity. The severity of certain infections, such as influenza, herpes simplex, and viral hepatitis, increases as pregnancy progresses. The course of respiratory pathology also gets worse due to limited diaphragmatic movement and decreased tidal volume resulting from uterine growth [4, 5].

A severe acute respiratory syndrome was a typical manifestation of the coronavirus disease in 2020, which raised concerns about a higher risk of severe infection in pregnant women and potential negative effects on the fetus and newborn [6]. According to studies, pregnant women did not...
have a higher prevalence of COVID-19 positive tests than the general population. However, pregnant women had a more severe course of the disease [6, 7]. Statistics show that during the pandemic, pregnant women suffering from COVID-19 required hospitalization at a rate of 31.5% compared to 5.8% for non-pregnant women. Pregnant women were significantly more often admitted to the intensive care unit and needed artificial lung ventilation [8]. If pregnant women are infected with COVID-19, the frequency of pre-eclampsia and preterm birth increases, as does the index of perinatal and neonatal morbidity and mortality [9].

Although there is a low rate of congenital infection among live-born babies whose mothers contracted COVID-19 during pregnancy, the frequency of small for gestational age babies and stillbirths rises as a result of inflammatory and vascular reactions from the placenta [10]. In addition, the risk of developing neurological dysfunctions, including convulsive disorders, increases in newborns after intrauterine contact with COVID-19 infection during the first and third trimesters of pregnancy [11].

One of the leading adverse factors affecting the course of pregnancy and childbirth during military aggression is stress. Pregnant women who experience high levels of stress are more likely to suffer complications, including preterm birth, placental dysfunction, preeclampsia, and intrauterine growth restriction [12].

The purpose was to study birth rate fluctuations and changes in the structure of early neonatal morbidity and mortality at Kyiv City Maternity Hospital 6 during the COVID-19 pandemic and martial law and to compare the obtained findings with national statistical data.

Materials and methods

A retrospective analysis and assessment of birth rate fluctuations, early neonatal morbidity, and mortality were carried out for 2020–2022 using both the health care industry statistics and the data obtained from Kyiv City Maternity Hospital 6, which is the clinical base of the Department of Pediatrics 2 of Bogomolets National Medical University.

Results and discussion

A three-year analysis of the birth rate at Kyiv City Maternity Hospital 6 revealed a consistent negative trend, with birth rates decreasing by about 20% annually (Fig. 1).

These data support the general trend of declining national birth rates. The COVID-19 pandemic resulted in a more rapid birth rate reduction in Ukraine. An 8.1% fall in it was seen in 2021, when only 262,102 children were born in health care facilities of the Ministry of Health of Ukraine, down from 285,248 in 2020 [13]. According to state records, just 195,000 little Ukrainians were born between February and December 2022, which is a third fewer than during the same period in 2021 [14]. The full-scale military invasion of Ukraine by Russia is to blame for the population loss and migration dynamics.

It is well established that gestational age at birth has a significant impact on both perinatal morbidity and mortality, as well as mortality in children under the age of five. About a million children die worldwide annually from complications associated with preterm birth [15]. According to the WHO, the rate of preterm birth in different countries ranges from 3 to 18% [16].

5.1% of the live births at Kyiv City Maternity Hospital 6 in 2020 resulted in preterm births. Preterm births declined by 0.8% in 2021 but increased by 0.3% the following year. However, this rate is not high when compared to the WHO data [16] or data for Ukraine (out of the total number of live births, 16,099 infants weighing less than 2,500 g were born in 2020 (5.67%), and 15,668 infants — in 2021 (6.01%) [13]).

Depending on the severity of the condition, 7.8% of all children required observation and treatment in the neonatal intensive care unit (NICU) in 2020. In 2021, this statistic saw a notable 1.3% rise and a further 0.1% increase under martial law.

In 2020, preterm newborns accounted for 63% of all patients in the NICU. The proportion of preterm newborns in the NICU decreased to 44.6% in 2021 and then increased to 49.5% in 2022, which corresponded to the dynamics of the preterm birth rate at Kyiv City Maternity Hospital 6 (Fig. 2). The degree of a baby’s morpho-functional immaturity affects the structure of their combined perinatal pathology [17]. In Ukraine, the overall morbidity of preterm newborns is 5.3 times higher than that of full-term newborns (835.6 versus 158.49%, respectively) [2].

All low- or extremely low-birth-weight newborns were admitted to the NICU. In 2020, this group accounted for 3.3...
and 4 % of the total live births, respectively. In 2021, there was a more than 2-fold decrease in the proportion of newborns with a birth weight of 500–999 g (1.5 %), while those with a birth weight of 1,000–1,499 g (3.8 %) experienced a 0.2% decrease. In 2022, very low-birth-weight infants accounted for only 1.4 %, but there were no cases of extremely low-birth-weight newborns. According to the regionalization system, Kyiv City Maternity Hospital 6 is a health care facility that provides level II perinatal care services. Such dynamics within the hospital can be explained by the 2021 new regulation stating that most labouring women with a gestation period of up to 34 weeks and an anticipated fetal weight of up to 1,500 g should be referred to the level III perinatal care centre.

In the nosological structure of 2020, perinatal involvements of the central nervous system were most prevalent and determined the severity of a newborn’s condition. They were mainly manifested by hypoxic-ischemic encephalopathy, including cerebral inhibition (14.4 ‰), cerebral excitation (0.8 ‰), convulsive disorders (1.4 ‰), intraventricular haemorrhages (1.1 ‰), and ventricular dilatation (1.1 ‰). Metabolic disorders were found to occur more frequently than other pathological conditions, particularly hypoglycemia (18.5 ‰) and unconjugated pathological hyperbilirubinemia (14.7 ‰), which can be observed in a variety of pathologies but are especially typical of preterm and low-body-weight newborns (4.2 ‰). The primary factors that contributed to respiratory failure in newborns were respiratory distress syndrome (4.2 ‰), respiratory distress associated with intrauterine hypoxia (2.5 ‰), and congenital pneumonia (2.0 ‰). The most common congenital malformations were represented by heart defects (2.0 ‰), followed by gastrochisis (0.6 ‰), lung malformations (0.3 ‰), omphalocele (0.3 ‰), spinal hernia (0.3 ‰), and anus atresia (0.3 ‰).

In 2021, the frequency of cerebral inhibition (18.5 ‰) rose by 4.1 ‰, cerebral excitation (5.6 ‰) by 4.8 ‰, convulsive disorders (2.1 ‰) by 0.7 ‰, and intraventricular hemorrhages (1.4 ‰) by 0.3 ‰, along with an increase in the birth asphyxia rate from 1.7 to 6.3 ‰. The obtained data reflect changes in the structure of perinatal involvements of the central nervous system. As a result of transient tachypnea (58.6 ‰) and congenital pneumonia (4.2 ‰), newborns had a significantly higher rate of diseases accompanied by respiratory failure, whereas the prevalence of respiratory distress syndrome declined to 3.8 ‰. At the same time, there was a 1.5-fold increase in the frequency of detection of hypoglycemia (27.9 ‰) and a 2.5-fold increase in unconjugated pathological hyperbilirubinemia (38.0 ‰), with a simultaneous increase in the percentage of low-birth-weight newborns to 6.3 ‰.

It should be noted that in 2021, compared to the previous year, there was an increase in the incidence of infectious diseases among newborns, including intrauterine infection with subsequent development of early-onset neonatal sepsis (2.4 ‰) by 1.3 ‰, congenital pneumonia (4.2 ‰) by 2.2 ‰, and necrotizing enterocolitis (4.9 ‰) by 2.9 ‰. The percentage of congenital heart defects grew to 3.5 ‰, while the rate of congenital lung defects remained at the same level as the previous year (0.3 ‰). In 2022, respiratory failure (77.8 ‰), which developed mainly due to transient tachypnea (64.4 ‰) and congenital pneumonia (5.1 ‰), was the leading cause of morbidity among newborns. The occurrence of perinatal involvements of the central nervous system tended to decrease, including cerebral inhibition (15.5 ‰) by 3.0 ‰, cerebral excitation (3.7 ‰) by 1.9 ‰, convulsive disorders (1.4 ‰) by 0.7 ‰, intraventricular hemorrhages (0.4 ‰) by 1.0 ‰, with a simultaneous increase in the birth asphyxia rate (8.0 ‰) by 1.7 ‰. The incidence of hypoglycemia (32.5 ‰) and unconjugated pathological hyperbilirubinemia (32.1 ‰) remained high, while the rate of intrauterine growth restriction decreased to 2.8 ‰.

In the structure of infectious diseases, there was an increase in the occurrence of nervous system disorders concomitant with intrauterine infection (3.3 ‰) by 0.7 ‰ and congenital pneumonia (5.1 ‰) by 0.9 ‰, with a simultaneous decrease in the rate of necrotizing enterocolitis (2.8 ‰) by 2.1 ‰, i.e., a pathology developing in the postnatal period.

The frequency of detection of congenital heart defects decreased more than three times, to 0.9 ‰. One case of spinal hernia (0.4 ‰) and one case of congenital lung defect (0.04 ‰) were observed.

Analysis of the changes in the morbidity structure of newborns over the past three years indicates a significant increase in the incidence of perinatal involvements of the central nervous system and intrauterine growth restriction, which is most often associated with placental insufficiency, as well as perinatal infections in 2021 compared to the previous and following years, while maintaining a progressive increase in the frequency of asphyxia and intrauterine infection in 2022 (Fig. 3, 4).

The percentage of newborns who required artificial lung ventilation in the NICU changed from 15.3 % in 2020 to 10.4 % in 2021 and to 8 % in 2022, reflecting fluctuations in the incidence of respiratory disorders in very low- or extremely low-birth-weight newborns. In 2020, 8 % of the NICU patients received non-invasive respiratory support with a nCPAP machine. In 2021, that rate fell to 5.8 %, and it rose to 6.1 % in 2022. The dynamics of the overall rate and the ratio of categories of preterm newborns treated in this department can account for these changes (Fig. 5).
In 2020, the early neonatal mortality rate was 2.82 ‰. 70 % of those who died were preterm newborns with a gestational age of 23–25 weeks, extremely low birth weight, and signs of severe morpho-functional immaturity, one of which is the persistence of the germinal matrix. That is why intraventricular haemorrhages, which accounted for 60 % of cases, prevailed as the cause of mortality. Among other causes of death, asphyxia accounted for 20 % of cases, and congenital pneumonia and congenital heart defects each accounted for 10 % of cases.

In 2021, early neonatal mortality decreased to 2.6 ‰. Among babies who died in the early neonatal period, full-term newborns predominated, and the proportion of preterm newborns with extremely low birth weight and gestational age of 23–28 weeks reduced to 43 %. The causes of mortality in preterm newborns were intraventricular haemorrhages, multiple congenital malformations of the nervous and cardiovascular systems, and asphyxia, each accounting for 14.3 % of cases. At the same time, the cause of mortality in full-term newborns was exclusively associated with congenital pneumonia (57 % of cases), and one of the mothers suffered from COVID-19 during pregnancy.

In 2022, early neonatal mortality decreased to 0.4 ‰. Only one newborn with a gestational age of 28 weeks and a low birth weight died due to congenital lung defects.

According to the obtained findings, early neonatal mortality at Kyiv City Maternity Hospital 6 has decreased over the past three years. In Ukraine, this indicator was 2.91 ‰ in 2020 and 2.96 ‰ in 2021 [13].

In 2020, there was a significant percentage of preterm newborns with very and extremely low birth weights and pronounced signs of morpho-functional immaturity, which resulted in a high incidence of intraventricular haemorrhages. The rates of preterm births and neonatal deaths fell in 2021. However, it should be noted that we observed a high mortality rate for congenital pneumonia in full-term newborns, which is associated with a significant risk of infection with COVID-19 during pregnancy.

Despite rising rates of birth asphyxia and congenital pneumonia in 2022, there was a further reduction in the early neonatal mortality rate. However, there was one case of congenital malformation-related death that requires additional attention and research (Fig. 6).

In 2020, 23.2 % of the NICU patients with severe perinatal pathology were transferred from Kyiv City Maternity Hospital 6 to other health care facilities for further treatment. In 2021, this indicator rose dramatically and reached 48.4 % due to an increase in the proportion of severe CNS damage manifestations and the number of perinatal infection cases.

To prevent the spread of infectious diseases in 2022, the Department of Infection Control (DIC) was opened at Kyiv City Maternity Hospital 6. Its main functions include the prevention of infectious diseases associated with the provision of health care, the introduction of the administration of antimicrobial drugs, epidemiological surveillance and keeping records of infectious diseases, the implementation of new clinical protocols for empiric antimicrobial therapy, conducting a retrospective audit of the compliance with the prescription of antimicrobial drugs, providing data on the consumption of antimicrobial drugs to public health institutions responsible for combating antimicrobial resistance, etc. A decrease in the incidence of postnatal infections, particularly necrotizing enterocolitis, can be regarded as one of the practical outcomes of the DIC’s work. Catamnetic observation became available in 2021. A total of 360 children are currently undergoing it.
Despite the war, the introduction of expanded newborn screening in Ukraine (October 2022) will certainly have a positive effect on newborn health. It includes a comprehensive examination of newborns that allows for the detection of 21 rare hereditary and congenital diseases (previously, only four rare diseases could be detected).

Monitoring of the child’s motor, cognitive, sensory, and socio-emotional functions as well as communication skills will help detect deviations in the child’s development in time and take appropriate measures to promote the child’s well-being. Pediatricians, neurologists, and ophthalmologists can identify potential developmental issues in children by assessing their health at the ages of 3, 6, 9, 12, 24, and 36 months using special scales and screenings recommended by the Ministry of Health of Ukraine. They can then offer the required medical assistance and rehabilitation.

Conclusions
The COVID-19 pandemic and ongoing Russia’s full-scale aggression contributed to the negative dynamics of the birth rate at Kyiv City Maternity Hospital 6, as well as in Ukraine as a whole, between 2020 and 2022.

Neonatal morbidity underwent significant changes during the peak of the COVID-19 pandemic in 2021, while maintaining a progressive increase in certain nosological forms.

In order to reduce neonatal morbidity, it is necessary to ensure a high level of health care for pregnant women, mothers, and newborns, as well as raise public awareness of perinatal issues and risks.

The dynamics of early neonatal mortality rates at Kyiv City Maternity Hospital 6, as well as in Ukraine, indicate a positive tendency for 2020–2022. A decrease in the mortality rate could be related both to the improvements in newborn care and the reduction of preterm births through the use of high-tech methods of prolonging pregnancy and preventing death in the early neonatal period and the introduction of regionalization of perinatal care provision. Although the trend toward lower early neonatal mortality is generally regarded as positive, more research and action are still required to address this issue.

Improving the pediatric service of Kyiv City Maternity Hospital 6 by opening the department of neonatal pathology, pediatrics, and rehabilitation, the department of infection control, and the catamnestic office, together with the introduction of expanded newborn screening, are important steps in providing high-quality newborn care.

References
Під час пандемії COVID-19 та воєнного стану в Україні стала знижуватися надання медичної допомоги новонародженим, що веде до зростання частоти неонатальної патології, пов’язаної з втратаючо-травматичною гіпоксією, а також з перинатальною інфекцією. Позитивною тенденцією є зниження рівня ранньої неонатальної смертності.

**Резюме.** Актуальність. Під час пандемії COVID-19 та воєнного стану народжуваність в Україні стала знижуватися швидкими темпами. Мета дослідження: вивчити та проаналізувати динаміку показників народжуваності, структури ранньої неонатальної захворюваності та смертності в КНП «Київський міський пологовий будинок № 6». Порівняти їх з загальнодержавними показниками, в умовах пандемії COVID-19 і воєнного стану.

Ключові слова: COVID-19, новонароджені діти, захворювання, смертність, воєнний стан

**Аналіз показників народжуваності, неонатальної захворюваності та смертності під час пандемії COVID-19 і воєнного стану в Україні.**

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**Anализ показателей рождаемости, неонатальной заболеваемости и смертности в период пандемии COVID-19 и военного времени в Украине.**

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