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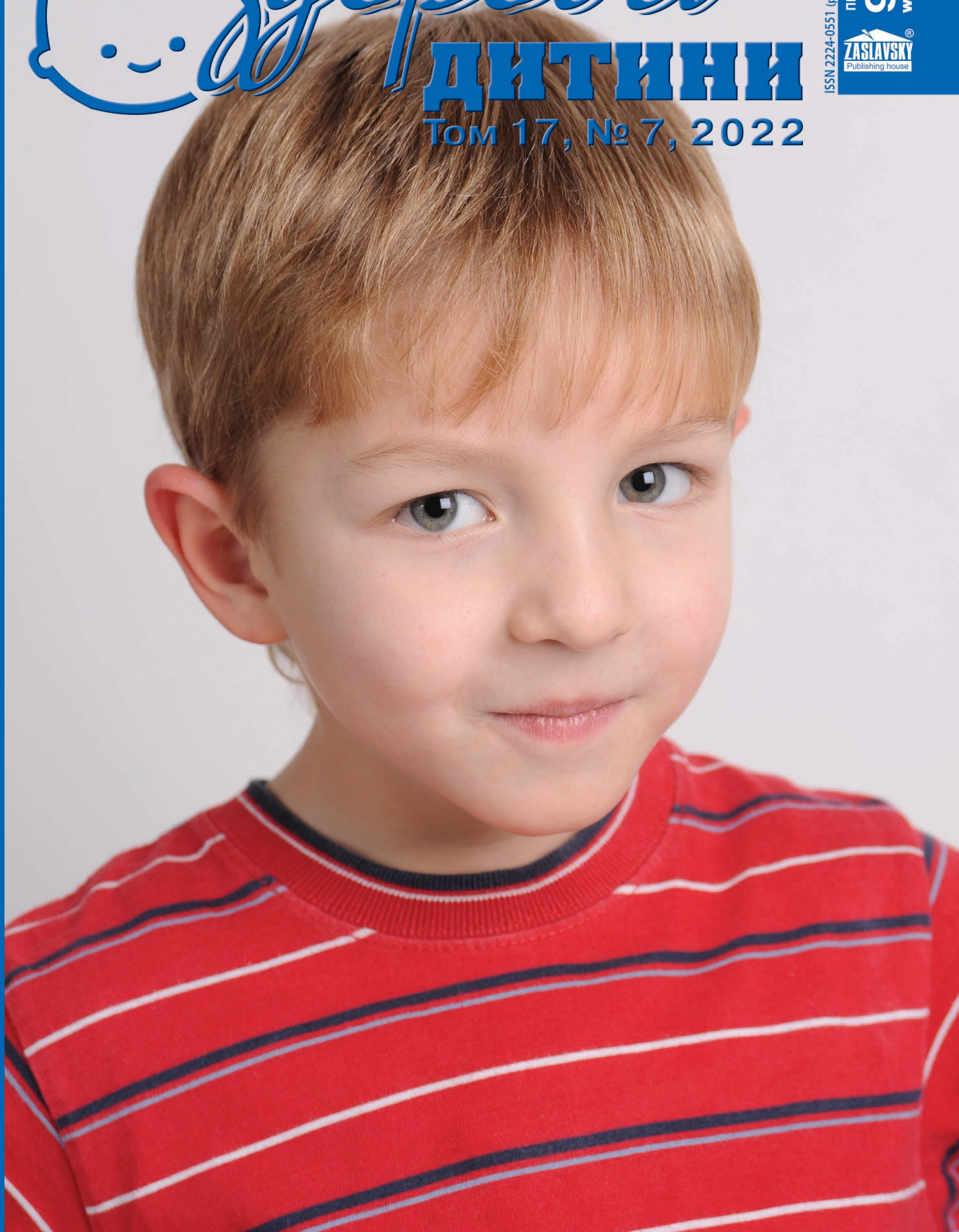
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Birth rate, perinatal mortality and infant mortality in Ukraine: evolution from 1991 to 2021 and current risks

Abstract. *Ukraine is one of the poorest countries in Europe and currently is under attack of Russian troops. In recent decades, birth rate in Ukraine has been steadily declining by 47 %, and infant and perinatal mortality rates remain among the highest positions in Europe. Infant mortality, perinatal mortality, early neonatal mortality, and stillbirth rates in Ukraine have more than halved in 30 years and are lower than in the CIS countries, but still exceed those in the European Union. There is a downward trend in characteristics of all components of perinatal mortality; more for intranatal mortality, less for early neonatal mortality, whose share in the structure has increased in recent years, which requires improving the quality of medical care for newborns and taking measures for antenatal protection of the fetus. The fact that early neonatal mortality rates in Ukraine may be underestimated due to shortcomings in the registration of live births and stillbirths is worrying. Congenital malformations and conditions that appeared during pregnancy and childbirth in women who give birth to children with very low and extremely low body weight dominate among the causes of perinatal mortality in Ukraine. An effective way to reduce child losses in Ukraine during the last decade was the introduction of modern perinatal technologies to prevent pathological conditions in mothers and babies with extremely low and very low body weight, the continuation of the creation and restoration of a network of perinatal centers and proper conditions for safe childbirth in the regions of the country with the help of international aid, timely diagnosis and treatment of conditions that occur in the perinatal period and congenital malformations. An important resource for reducing infant and perinatal mortality in Ukraine and increasing the birth rate will be the stabilization of the sociopolitical situation in the country and appropriate international assistance in restoring the health care system, aimed at improving both somatic and reproductive health of future parents, especially mothers, forming in them a conscious and proper attitude to parenthood and care for the newborn.*

Keywords: *birth rate; infant mortality; perinatal mortality; stillbirth; perinatal centers*

Introduction

The United Nations and the World Health Organization have considered the reduction of infant mortality among the main goals of the millennium [3, 11, 20]. According to UNICEF, 5 million children under the age of 5 died in 2020 alone. Almost half of these children died in the first month of their life. In addition, nearly 2 million

children were stillborn, meaning that a stillborn baby is born every 16 seconds in the world. Thus, in 2019, 1.9 million children were stillborn within 28 weeks of pregnancy or later, with a global stillbirth rate of 13.9 per 1000 births [14, 19, 23].

More than 40 percent of all stillbirths occurred during childbirth. This could have been prevented through ongoing

ing audits of such cases, improved monitoring, increasing of quality of prenatal and postnatal care and adequate access to emergency obstetric care when needed. Significant advances in research, particularly in medical genetics, have made important contributions to increasing neonatal survival, reducing perinatal losses, and limiting and reducing fetoneonatal pathology, which is still very difficult to control [13, 17, 20, 22, 28].

Social protection of the population, age of mothers, birth rate, perinatal mortality, and quality of medical care for mothers and children are interconnected and interdependent things [1, 4, 16, 24].

Ukraine is one of the largest countries on the European continent with low income, which has a number of problematic issues in the quality of medical care for women and children. During the last decades, against the backdrop of high mortality, the birth rate has been constantly decreasing, and the Ukrainian infant and perinatal mortality rates remain among the highest in Europe [1, 2, 4–6, 10].

Our analysis of the incidence and prevalence of diseases among the Ukrainian children's population and the levels of infant mortality over the past two decades shows that these indicators remain significantly higher than the European average level. This mirrors the background of progressive decline in the children's population. The prevalence of childhood diseases in Ukraine has increased by 41 % over the past 22 years, and the incidence of childhood diseases has raised by 36 %. The number of newborns is progressively decreasing to less than 300 000 per year. At the same time, the number of congenital malformations (hereinafter — CM) and neoplasms among children in Ukraine have doubled in recent decades [1, 5, 7, 25, 26].

That is why a constant monitoring of birth rates and perinatal mortality is necessary for making systemic decisions on improving the quality of medical care for children [18, 20].

The purpose of the study is to study and analyze trends in birth rate changes and dynamics of infant and perinatal mortality together with its components in Ukraine in comparison with data from other countries.

Materials and methods

A retrospective analysis and assessment of the dynamics of births and perinatal mortality and its components in Ukraine from 1991 to 2021 according to the database of the World Health Organization, European Health for All database (HFA-DB), state statistics of Ukraine, industry statistics of the Center medical statistics of the Ministry of Health of

Ukraine, perinatal audit of the birth rate, infant and perinatal mortality in accordance with the WHO methodology “Matrix-Babies” [6, 7, 14, 15, 27]. Methods of system approach, statistics, and graphic image are applied.

Results and discussion

During the period of Ukraine's existence as an independent country, the number of live births decreased by 2.4 times — from 630.8 thousand in 1991 to 272.0 thousand in 2021.

Among the total number of live births, 14 787 children, or 5.68 % were born prematurely in 2021 and from the number of stillbirths, premature ones make up to 1151 cases or 67.1 %. The incidence of premature infants exceeds the incidence of full-term infants by 5.3 times (835.6 ‰ against 158.49 ‰, respectively). Mortality of premature infants in obstetric hospitals, which is up to 3.54 cases per 100 live births who became ill, exceeded the corresponding figure of full-term (0.37) by 9.56 times.

Over the last 10 years in Ukraine we can see the tendency of increasing the number of premature babies by 21.2 % and increasing of their morbidity is alarming in general. This indicates a number of significant problems in the health of pregnant women, namely — the incidence of inflammatory diseases of the female genital organs, anemia, diabetes, pathology of thyroid glands, circulatory system diseases and genitourinary system diseases [5].

Because of the reasons listed above, every 12th child in Ukraine is born prematurely. The youngest child born and survived in Ukraine weighed 470 g, while there are survived children with weight just over 220–230 g in the world. At the same time, the introduction of modern perinatal technologies has allowed the reducing of the number of complicated births almost twice in the last 20 years [1, 9, 10].

The dynamics of the total birth rate had different directions in terms of overall mortality and infant mortality. There was a significant decrease in the birth rate in 1991–

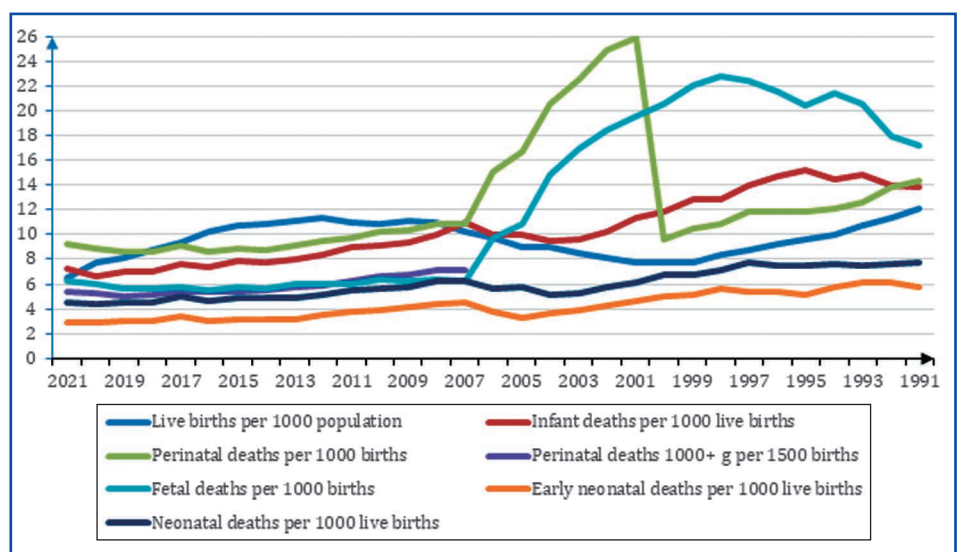


Figure 1. Birth rate, infant mortality, perinatal mortality, stillbirth, neonatal and early neonatal mortality in Ukraine in 1991–2021 according to the European Health for All database (HFA-DB) and the Center for Medical Statistics of the Ministry of Health of Ukraine

2001 from 12.1 ‰ per 1000 population in 1991 to 7.7 ‰ in 2001. Then, in parallel with the growth of living standards, this indicator reached its maximum level in 2012 at 11.4 ‰ and with a further tendency to deteriorate to the lowest figure in the history of Ukraine at 6.5 ‰ in 2021 (7.8 ‰ — 2020 year), which is associated with the deterioration of the socio-economic situation in the country due to the background of Russia's annexation of Ukraine in 2014 and the beginning of the war in the East (Figure 1). Undoubtedly, the situation with the birth rate has been worsened by the ongoing COVID-19 pandemic.

That is why, if we compare the number of births in Ukraine in 2021 with the figure from 2013, we can say that the birth rate has decreased almost twice over the past 8 years. It should be noted that according to state statistics of Ukraine in recent years, natural population growth in Ukraine is consistently negative, and the total fertility rate does not exceed 1.5 children per woman, which does not allow the country to achieve even simple population reproduction. According to UN estimates, Ukraine's population will shrink to 35 million by 2050: "Low birth rates, high mortality rates, and steady growth in external migration are the main reasons for Ukraine's population decline. However, population reduction alone is not a problem. What is really important is the level and quality of life of the Ukrainian people" [23].

Of course, the current challenges that our country is facing, require the implementation of effective systems of state, sectoral and regional measures aimed at creating conditions for a full-fledged life and development of the child from birth to adulthood.

Analysing the structural distribution by birth weight of babies born alive, babies with a normal weight of 2500 g and more prevail with 93.98 % or 244,834 babies. Infants with an intermediate birth weight of 1500–2499 g make up 5.04 % or 13144 babies. Very low birth weight (VLBWI) infants with weight less than 1500 g (including those with a birth weight of less than 500 g) accounted for 0.96 % or 2,524 infants. It should be noted that the incidence of children in this weight category is 3 times higher than the incidence of newborns with weight more than 2500 grams because particularly newborns with low birth weight have an increased risk of maladaptation and severe pathological conditions that require constant monitoring according to their state of health and necessary treatment and prevention measures.

Evidently, the share of children with very low birth weight from the total number of live births in the dynamics of the last 14 years of observation tended to increase: from 0.71 % in 2008 to 0.96 % in 2021, or 35.2 % (Table 1).

Overall, over the past two decades, there has been a modest 11.5 % increase in the incidence of births of children with weight less than 2500 grams at births from 5.38 % in 2000 to 6.01 % or 15 668 children in 2021.

It is known that infants not only with extremely low birth weight but also with very low and moderately low weight have a notably high risk of impaired neuropsychological development, in particular, when they reach adolescence [16].

In 2021, the number of children with very low birth weight in Ukraine exceeded the number of premature ba-

bies (14 787 children) by 5.8 %, which indicates the existing problems in the health of fertile women. It should be noted that in 2000 the excess of the number of children with a very low birth weight over the number of premature babies was even more significant and reached to 11.6 %.

According to the data presented above, in 2021, 881 (0.34 ‰) full-term infants were born with weight less than 2500 g, which may indicate the development of such children with the syndrome of intrauterine growth retardation. This in turn will lead to an increase in morbidity, conditions that arose in the perinatal period, in particular — hypoxic-ischemic lesions of the central nervous system and birth injuries. In future such children are often seriously ill and over time they may become disabled due to neuropsychiatric disorders.

Thus, as can be seen from Table 1, for the last 14 years in the structural distribution of children that were born alive the following changes happened in body weight at birth: the specific weight of babies born with a very low birth weight (less than 1500 g) increased most significantly; the specific weight of babies with an intermediate (1500–2499 g) weight increased by 13.1 %; the specific weight of children with a normal (2500 g or more) body weight at birth decreased by 2.9 %.

Thus, the birth rate in Ukraine has a steady downward trend, while there is an increase in the incidence of newborn diseases, including perinatal pathology and congenital malformations (more than 10 000 babies with CM were born in 2021 alone, one-third of whom were diagnosed with disability). At the same time, infant mortality remains at a level that is significantly higher than in most European countries (Figure 2). Thus, 15.3 thousand children in Ukraine were recognized as persons with disabilities for the first time in 2021 alone (6.4 thousand children of which were in the first two years of life), and the total number of children with disabilities in Ukraine exceeded 162 thousand people.

The number of the child population in Ukraine over the past 30 years has decreased from 13 225 700 to 7 459 677 or by 43.6 %. Every 11th newborn child has a health disorder that leads to the chronic diseases and childhood disabilities [1, 9]. In 2017, more than 49 000 children with congenital anomalies (developmental defects), deformities, and chromosomal aberrations were registered. Currently, against the background of the declining child population, there is a trend of increasing of the frequency of premature births and births of children with severe perinatal pathology, which leads to disability that impairs their socialization, quality of life and requires high-tech diagnostic and treatment methods [10].

Due to the ongoing war on the territory of Ukraine there is a significant number of refugees among them women of reproductive age. Large human losses also do not give us the optimism to improve these indicators in the coming decades.

Modern principles of perinatal care are based on the WHO concept of effective care during pregnancy and child-birth [3, 22].

In 1991, the infant mortality rate in Ukraine was 13.9 ‰ live births, and the perinatal mortality rate was 14.3 ‰ births (according to WHO project calculations, at that time it was twice as large due to shortcomings in the registration of live births in the country only from the 28th week of pregnancy).

The level of specific infant mortality rate in health care facilities managed by the Ministry of Health of Ukraine for 12 months of 2021 was 7.22 per 1000 live births, which is almost two times less than in 1991. A shocking number of 1,971 children under one year died in 2021. 1123 of them (or 56.9 %) died as a result of certain pathological conditions that have appeared in the perinatal period.

The positive dynamics of the decrease in the infant mortality rate observed in 2021 were due to the decrease in the levels of perinatal, early neonatal, neonatal mortality, and stillbirth (Figure 1).

In the structural distribution of infants who died under the age of 1 year, according to the body weight at birth, the weight category of 2500 and more prevails and makes up 40.56 %. The weight category of 1500–2499 g

makes up 22.32 %, the weight category is less than 1500 g is 37.10 %.

According to the World Health Organization, the proportion of live births and stillbirths with a body weight of 500–999 g among all live births and stillbirths should be 1–1.5 %, and the proportion of live births and stillbirths with a body weight of 1000–1499 g among all those born alive and dead should also be equal to 1–1.5 %. In Ukraine, according to the Center for Medical Statistics of the Ministry of Health of Ukraine, the specific weight of live births and stillbirths in the specified weight categories is almost twice as low, 0.46 % and 0.73 %, respectively.

According to the World Health Organization's birth weight classification, a baby with a birth weight of < 1500 g is classified as one with a very low birth weight (VLBWI), and

Table 1. Distribution of children that were born alive by birth weight at 22 weeks of gestation in health care facilities under the Ministry of Health of Ukraine control according to the Center for Medical Statistics of the Ministry of Health of Ukraine (as a percentage)

Body weight at birth, g	2008	2010	2012	2015	2017	2019	2020	2021
Less than 1500	0.71	0.73	0.72	0.80	0.81	0.83	0.87	0.96
1500–2499	4.44	4.57	4.58	4.86	4.94	4.97	4.81	5.04
2500 and more	94.85	94.68	94.68	94.32	94.26	94.20	94.32	93.98

Table 2. Neonatal survival rate after the first 168 hours of life per 100 live births (as a percentage) according to the Center for Medical Statistics of the Ministry of Health of Ukraine

Years	Total	Including in the weight category at birth, g						
		500–999	1000–1499	1500–1999	2000–2499	2500–2999	3000–3499	3500 and more
2001	99.36	24.35	85.39	92.83	97.78	99.60	99.81	99.82
2002	99.38	27.55	87.58	93.44	97.99	99.58	99.81	99.84
2003	99.45	29.60	88.04	94.40	98.12	99.67	99.84	99.84
2004	99.47	28.83	89.91	94.56	98.32	99.61	99.83	99.85
2005	99.43	30.49	83.88	93.65	98.28	99.61	99.82	99.83
2006	99.46	36.43	84.07	94.26	98.27	99.67	99.80	99.84
2007	99.54	50.27	84.90	93.78	98.52	99.64	99.83	99.87
2008	99.55	55.03	85.21	94.87	98.49	99.69	99.86	99.85
2009	99.59	55.19	84.83	95.68	98.75	99.69	99.86	99.88
2010	99.61	56.27	87.39	96.12	98.87	99.73	99.87	99.87
2011	99.62	57.58	87.34	96.36	98.91	99.75	99.87	99.89
2012	99.65	57.82	87.74	96.52	98.90	99.77	99.90	99.91
2013	99.69	63.80	89.76	97.05	99.09	99.79	99.90	99.92
2014	99.69	65.06	89.44	97.33	99.00	99.81	99.90	99.91
2015	99.68	63.88	90.41	97.13	99.27	99.79	99.89	99.92
2016	99.69	64.88	91.20	97.56	99.18	99.79	99.91	99.91
2017	99.66	60.09	88.46	96.92	99.09	99.79	99.91	99.94
2018	99.70	62.97	89.84	97.33	99.31	99.83	99.91	99.93
2019	99.70	63.03	91.27	97.29	99.31	99.82	99.92	99.93
2020	99.71	65.86	91.87	97.61	99.32	99.83	99.89	99.94
2021	99.70	67.33	92.93	97.05	99.21	99.82	99.93	99.92

among them, an infant with a birth weight of < 1000 g is classified as a child with extremely low birth weight (ELBWI). The reason for using this classification is that VLBWI and ELBWI refer to high-risk babies who belong to early prematurity and have a high risk of death. Therefore, the survival ratio (SR) of VLBWI and ELBWI is usually analyzed as a criterion of determination of the survival prognosis of pre-term infants.

SR for ELBWI in Ukraine in 2021 was 67.33 %, which is 2.77 times higher than in 2001 when it was 24.5 %.

SR for VLBWI in Ukraine in 2021 was 92.93 %, which is 1.1 times higher than in 2001 when it was 85.39 % (Table 2).

This increase in the survival rates of children with extremely low body weight and very low body weight in Ukraine indicates the development of regionalization of perinatal care and the effectiveness of perinatal centers launched in 2010–2014 and is in line with global trends [1, 4, 21, 22, 24].

At the same time, the structure of deaths of children under the age of one year is as follows: conditions that occurred in the perinatal period raised to 56.9 %, CM raised to 22.2 % (almost a one-third of cases due to CM of the cardiovascular system), external causes — 3.47 %, diseases of the respiratory system — 3.17 %, infectious and parasitic diseases — 2.7 %, sudden infant death syndrome — 2.11 %, diseases of the nervous system — 2.5 %, diseases of the circulatory system — 1.5 %, tumors — 1,15 %.

Over the last decade in the structure of infant losses in Ukraine the specific weight of certain conditions that appear in the perinatal period increased by 11.9 %, neoplasms by 8.1 %, and respiratory diseases by 1.2 %.

sudden infant death syndrome decreased by 42.7 %, external causes of death by 41.1 %, diseases of the nervous system by 18.8 %, some infectious and parasitic diseases decreased by 6.9 %, congenital malformations, deformities, and chromosomal abnormalities by 6.4 %.

Our correlation-regression analysis of live and dead birth rates with body weight from 500 to 999 grams per 1000 births live and dead with a proportional perinatal mortality rate per 1000 births, showed their direct significant relationship ($r = 0.534$), which was statistically significant ($p < 0.05$). This indicates the existing connection between perinatal mortality and an increase in the proportion of births of children with extremely low body weight.

This is evidenced by the following correlation-regression analysis of live and dead birth rates weighing from 1000 to 1499 grams per 1000 births, living and dead with a proportional perinatal mortality rate per 1000 births showed only a direct moderate relationship ($r = 0.269$) that was statistically insignificant ($p > 0.05$)

The correlation-regression analysis of early neonatal mortality and morbidity of premature infants per 1000 live births did not show a direct significant relationship ($r = -0.097$) and was statistically unlikely ($p > 0.05$). At the same time, the correlation-regression analysis of infant mortality rates per 1000 children and the incidence of infants in the first year of life per 1000 children showed a direct moderate relationship ($r = 0.309$), which was also statistically insignificant ($p > 0.05$).

However, despite the positive dynamics of the reduction in infant mortality over thirty years of observation, Ukraine, according to the European Health for All Database (HFA-DB), still lags far behind developed countries (Figure 2).

Infant mortality rates in European countries were much lower than in Ukraine: Estonia — 1.5 ‰, Norway — 2 ‰, Finland — 2 ‰, Belarus — 2.5 ‰, Czech Republic — 2.6 ‰, Italy — 2, 9 ‰, Israel — 3,0 ‰, Germany — 3,2 ‰, Great Britain — 3,9 ‰, Poland and France — 4 ‰, the EU — 3,5 ‰, and the European region — 6,2 ‰. At the same time, Ukraine's indicator is one and a half times lower than in the CIS countries (Figure 2).

Because of Russian aggression, we expect a significant increase in the number of premature births, as women from the war zone and refugees experience stress and trauma during the war and are unable to reach medical facilities, and have to give birth in poorly adapted conditions. In future we are expecting a deterioration in infant and child mortality rates in Ukraine as a whole, due to the growing share of children killed in the war. As of July 2022 alone, more than 350 children

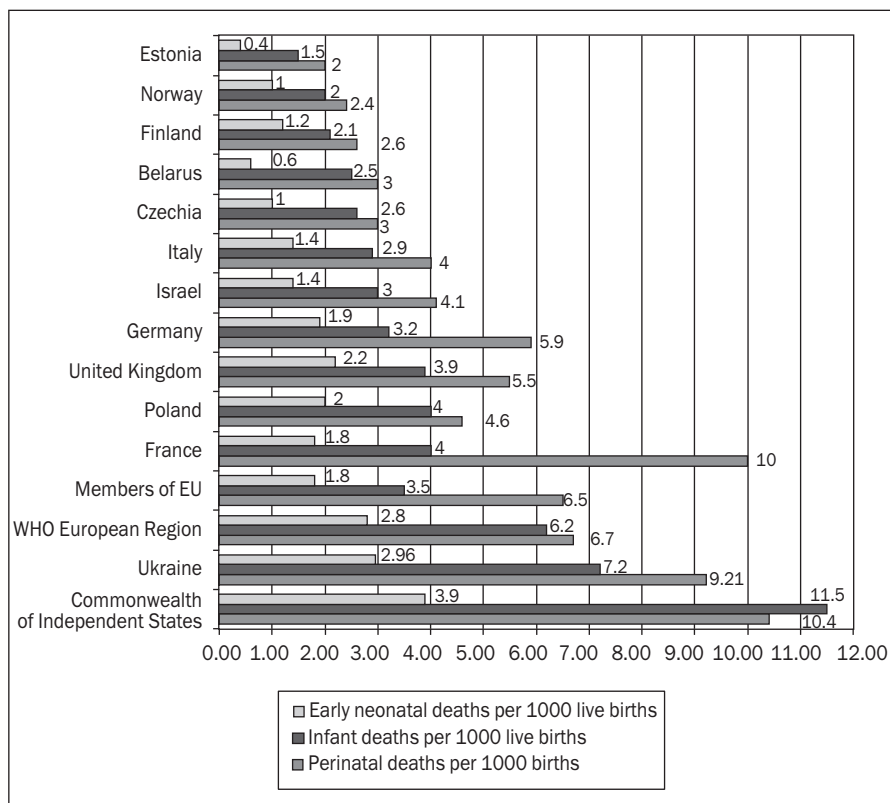


Figure 2. Infant, perinatal, and early neonatal mortality in Ukraine and Europe

have died and 700 have been injured and disabled as a result of Russian aggression. The fate of nearly 2000 children captured by the occupiers is unknown. It should be noted that more than 330 hospitals in Ukraine have been destroyed, including orphanages and maternity hospitals, especially in the east and north of the country. This will certainly worsen the quality of care provided to mothers and children, as well as the fact that many doctors have become refugees and gone abroad and will not be able to provide care to their patients. This will be a serious challenge for childhood medicine in Ukraine, as before the war the staffing of pediatricians did not exceed 80 % due to significant migration to EU countries.

Throughout the period of our research, we observed a constant excess of mortality up to 1 year among boys compared to girls: 55.2 % vs. 44.8 %, respectively. It should be noted that in 1990 this ratio was even more significant — 58.6 % of deaths of boys in the overall structure of infant mortality against 41.4% of deaths of girls.

It should be noted that the dynamics of reducing infant mortality in Ukraine has determined the nature and dynamics of trends in perinatal, early neonatal, neonatal, and post-neonatal mortality.

In the structure of infant death on the 1st place are children who died aged 0–6 days, on the 2nd place are children who died aged 28 days to 1 year, on the 3rd place are children who died aged 7–27 days.

The infant mortality rate is highly dependent on the quality of care provided to infants in the perinatal period (before, during, and after delivery). It is the assessment of perinatal mortality that can be used to characterize the health of newborns and identify problematic issues of medical care for children and mothers [2, 5, 20]. In 2021, the largest loss of children in Ukraine was recorded in the first week of life after birth (41 %), 22 % from 7 to 27 days of life, the next critical period is the period after 28 days of life, when 31 % of children died.

The World Health Organization is categorizing the causes of perinatal mortality as follows: congenital malformations; obstetric reasons; other causes, including chronic or acute maternal diseases during pregnancy and childbirth. At the same time, in Ukraine, the causes of perinatal mortality are dominated by conditions that occurred during pregnancy and childbirth in premature infants with very low and extremely low body weight (up to 70 %), second place (22–24 %) is taken by congenital malformations and anomalies. In 2021 alone, 1123 children died as a result of perinatal conditions, which was 0.16 % of the total number of deaths in the country. This was the main cause of losses in the perinatal period and accounted for 46.5 % of the total number of children who died in the perinatal period.

A total of 2413 children died in the perinatal period in 2021 (1551 antenatal deaths, 91 intranatal deaths, and 771 deaths in the first 6 days of life).

The level of perinatal mortality in health care facilities managed by the Ministry of Health of Ukraine for 12 months of 2021 was 9.21 per 1000 live births and stillbirths, which is almost 1.55 times less than in 1991 (14, 2 ‰).

Apparently, this reduction was primarily due to the creation of a network of level III perinatal centers in most regions of Ukraine with the provision of highly qualified

medical care for newborns, based on the use of modern medical equipment, help to the regional health care centers from the Institute of Pediatrics, Obstetrics and Gynecology named after Academician O.M. Lukyanova (NAMS of Ukraine) that includes introduction of innovative technologies, advanced training of medical staff of maternity hospitals, which contributed to the growth of survival of premature infants with extremely low and very low body weight [1, 10].

According to the Center for Medical Statistics of the Ministry of Health of Ukraine, the reduction in perinatal mortality was achieved mainly due to a twofold reduction in early neonatal mortality (from 5.8 ‰ in 2000 to 2.96 ‰ in 2021) and a decrease in stillbirth (from 17.2 ‰ to 6.27 ‰ respectively). At the same time, it is necessary to take into account the fact that according to the “Matrix-Babies” perinatal audit methodology, the real rate of early neonatal mortality exceeds the actual rate by 2.2–2.3 times from year to year, which may lead to an underestimation of the overall rate of perinatal, neonatal and infant mortality in Ukraine in general. Failure to take into account the loss of live births and stillbirths, or unregistered births, is the main reason for the underestimation of the early neonatal mortality rate [5, 8].

As can be seen in Figure 2, with the overall positive dynamics of the decrease in perinatal mortality in Ukraine, its level is now 1.4 times higher than the average in the European region (6.7 ‰) and the European Union (6.5 ‰), but less than in the CIS countries (10.4 ‰). Still this is a high level of perinatal mortality when we compare Ukraine with the developed countries of the world. It could be explained by the high level of perinatal losses in health care institutions of large industrial centers, which may be related to deficiencies in their equipment, insufficient qualification of personnel, high morbidity congenital malformations and the negative impact of a polluted environment.

That is why reducing of such significant perinatal losses is in a great priority. The negative trend of increasing the frequency of congenital malformations and hereditary diseases in children of Ukraine may be caused by an increase in the mutagenic and ecotoxic load on the population of reproductive age, in particular, as medical consequences of the accident at the Chernobyl NPP, and requires not only the restoration of ecological environment in regions polluted by chemicals and radionuclides but also a creation of an effective system of education of the population about a healthy lifestyle and nutrition.

All this requires the launch of state and regional programs and patronage projects in Ukraine to monitor the health of the future mother, pregnancy condition and development of the fetus. The introduction of modern standards of safe childbirth and measures aimed on preserving the reproductive health of young people is also very important.

The discordant nature of changes in perinatal mortality at the beginning of the 21st century (Figure 1) was due to the fact that until 2006, according to Ukrainian legislation, the perinatal period began from the 28th full week of fetal life to 7 days after birth. Since 2007, our country has moved to the world criteria for determining the timing of the perinatal

period, set by the WHO, when the beginning of the perinatal period falls on 22 full weeks (154 days) of fetal life.

In the dynamics of observation over the last twenty years, the specific weight of deaths in the antenatal period remained practically unchanged, while in the early neonatal period it is increased by 31.5 % (from 24.3 % to 31.95 %). The level of the proportional indicator of intranatal fetal deaths for the period 2001–2021 has significantly decreased from 2.94 per 1000 live births and stillbirths to 0.35, i.e. 8 times.

According to the WHO, the level of perinatal mortality should be regulated by its high level among those born with very low body weight (less than 1500 g), which, in turn, is due to its high level among those born with extremely low body weight (500–999 g).

Analysis of the proportional perinatal mortality rate (proportional ratio of birth weight to the total number of live births and stillbirths in all weight categories) according to “Matrix-Babies” showed a decrease in perinatal mortality in Ukraine from 2001 to 2021 by reducing this figure in all weight groups infants, especially in the group that has weight less than 1500 g.

It should be emphasized that this was mainly the result of a significant (more than 5 times!) decrease of the early mortality of children born with a body weight of less than 1000 g ($p < 0.01$), except for the weight category of 1000–1499 g, where, on the contrary, an increase was observed (Table 3).

As can be seen from Table 3, perinatal mortality in the group of births with extremely low body weight (550.17 per 1000 live births and stillbirths) was 2.9 times higher than in those born with very low body weight (184.14 ‰), also 11.3 times higher compared to the group of those born with low body weight, and 212 times higher than that of those born with normal body weight (4.51 ‰). In the following weight groups, perinatal mortality is markedly reduced. Perinatal mortality rates at fetal body weight from 3000 to 3500 g and from 3500 are minimal (2.37 ‰ and 2.21 ‰, respectively).

In Ukraine we had a significant level of perinatal mortality until 2006 was due to its high level among newborn children with weight less than 1500 g (19.58 ‰ against 7.58 ‰ in 2001), and from 2007 — due to a high level among newborn children with weight 1500 g and more (3.65 ‰ against 6.73 ‰), which in turn was connected with high level

Table 3. Specific indicator of perinatal and infant mortality in health care facilities subordinated to the Ministry of Health of Ukraine, by individual weight categories for 12 months of 2021

Weight categories, g	Antenatal	Intranatal	0–6 days	Perinatal	7–27 days	28 days — up to 1 year	Infant mortality	Percent survival after	
	Per 1000 live births and stillbirths		Per 1000 people-bride-groom alive	Per 1000 live births and stillbirths	Per 1000 live births			6 days	1 year
500–999	307.69	24.25	326.66	550.17	153.94	91.36	571.96	67.33	42.80
1000–1499	118.94	3.13	70.71	184.14	41.59	30.90	143.20	92.93	85.68
1500–1999	71.89	2.60	29.53	101.82	18.63	22.50	70.65	97.05	92.93
2000–2499	20.99	1.04	7.86	29.72	4.08	9.32	21.26	99.21	97.87
2500–2999	5.41	0.26	1.79	7.45	1.15	3.44	6.37	99.82	99.36
3000–3499	1.59	0.07	0.67	2.33	0.43	1.42	2.52	99.93	99.75
3500 and more	1.21	0.19	0.82	2.21	0.33	1.21	2.36	99.92	99.76
Total	5.92	0.35	2.96	9.21	1.59	2.67	7.22	99.70	99.28
Less than 1500	191.46	11.24	153.10	324.77	50.36	77.76	281.22	84.69	71.88
1500–2499	32.49	1.40	12.55	46.01	12.17	7.23	31.95	98.74	96.80
2500 and more	2.09	0.15	0.92	3.16	1.68	0.51	3.12	99.91	99.69
Total	5.92	0.35	2.96	9.21	2.67	1.59	7.22	99.70	99.28
Less than 1500	191.46	11.24	153.10	324.77	77.76	50.36	281.22	84.69	71.88
1500 and more	3.69	0.22	1.52	5.41	0.86	2.21	4.59	99.85	99.54
Total	5.92	0.35	2.96	9.21	1.59	2.67	7.22	99.70	99.28

among those born with a normal birth weight (2500 g and more). Since 2007 the level of the proportional indicator of antenatal death of fetuses in the weight category of 1500 g and more exceeds the corresponding indicator among fetuses in the weight category of less than 1500 g.

At the same time, in 2021, the level of the proportional indicator of perinatal mortality was high in the group of newborns with a body weight of 1500 g and more (intermediate and normal body weight at birth), which is 1.4 times higher than the level of the proportional indicator of perinatal mortality among those who have born with a low body weight at birth (less than 1500 g): 3.86 ‰ versus 5.35 ‰. This may indicate both the incorrect registration of births and deaths of children with very low birth weight, as well as the presence of problems in the organization of perinatal care in Ukraine, in particular, in the provision of medical care to the mother and fetus in the antenatal period.

In order to reduce the level of proportional perinatal mortality in newborns with low birth weight (less than 1500 g), which depends primarily on the state of women's health before pregnancy, it is necessary to develop an effective measures for improvement of health care, prevention, early detection and treatment of extragenital pathology among girls under 17 and women of childbearing age.

According to the World Health Organization, the ratio of stillbirths to deaths in the early neonatal period should be 1 : 1. The number of stillbirths in Ukraine exceeds the number of infants who died in the early neonatal period. This ratio decreases over time. If in 2001 there were 3 stillbirths per 1 death, then in 2021 there are almost 2 stillbirths per 1 newborn in the early neonatal period (the proportional rates of early neonatal mortality and stillbirth are 2.96 and 5.92 per 1000 of all those born alive and dead respectively).

As indicated by R.V. Marushko and O.O. Dudina (2020), a separate analysis of antenatal and intranatal fetal deaths in Ukraine shows that the current perinatal situation in the country is characterized by a significant proportion of antenatal fetal deaths [5]. Thus, the level of proportional antenatal deaths of fetuses with weight 1000 g and more in Ukraine today is 5.92 per 1000 live births and stillbirths. Therefore, during the period 2001–2021 it has decreased by 2.92 times from 17.3 ‰ per 1000 live births and stillbirths in 1991 to 5.92. The significant decrease of this indicator in 2007 was due to official changes in the live birth criteria in Ukraine and was not due to other objective reasons. However, in the last 7 years, there has been a gradual increase in this indicator.

According to the World Health Organization, a high level of proportional antenatal death of fetuses with weight 1000 g or more among all dead fetuses before childbirth depends on the state of health of the woman before and during pregnancy, and the state of medical care for pregnant women in women's clinics, obstetrics and pediatric (neonatology) hospitals.

Since 2007, the level of the proportional indicator of antenatal death of fetuses in the weight category of 1500 g and more exceeds the corresponding indicator among fetuses in the weight category of less than 1500 g, which indicates

shortcomings in the medical care for the mother and fetus in the antenatal period. The level of the proportional indicator of intranatal mortality (0.35 per 1000 live births and stillbirths) was high among those children that born with normal weight (2500 g and more) and low weight (less than 1500 g), which are respectively 0,14 ‰ and 0.07 ‰.

Among all fetuses that died before the beginning of delivery, fetuses weighing 1000 g or more accounted for 76.35 %. According to the World Health Organization, the high level of the proportional indicator of intranatal death of fetuses weighing 2500 g or more indicates the shortcomings that occur during childbirth with a normal-weight infant.

According to the WHO, about 44 % of all deaths of children under 5 years of age occur only in the neonatal period. The structure of the main causes of death of newborns in 195 countries of the world: 27 % due to infections specific to the perinatal period, including pneumonia, 23 % due to intranatal complications, and 10 % due to congenital anomalies.

In 2021 the Ukrainian neonatal mortality rate was 4.55 ‰ per 1000 of all live births. In the dynamics of a thirty-year observation, this indicator decreased by 1.7 times (in 1991 it was 7.8 ‰), primarily due to the introduction of modern medical technologies into the practice of healthcare institutions in Ukraine. In 2021 the rate of neonatal mortality of premature infants (29.62 ‰) was 51 times higher than the rate of neonatal mortality of full-term children (0.58 ‰) and 13.8 times the national rate of neonatal mortality of children (2.23 ‰).

The leading causes of neonatal mortality were: neonatal sepsis and congenital pneumonia (28.2 %), respiratory distress syndrome (23.7 %), intrauterine hypoxia (19.0 %), intracranial trauma (9.3 %), and birth trauma (8.8 %).

And if in 1991 neonatal mortality was 56.11 % of the infant mortality rate, then in 2021 it was 63.2 % of the total rate, which corresponds to global dynamics [5].

In turn, early neonatal mortality accounted for 74.25 % of neonatal mortality in 1991, and in 2021 this percentage decreased to 64.1 %. According to the World Health Organization, the proportional rate of early neonatal mortality for babies with weight 1500 g or more should be equal to 1 per 1000 of all live births and stillbirths.

In Ukraine during 2021 this indicator was 2.94 per 1000 of all live births and stillbirths, which does not correspond to global trends. In the dynamics of a thirty-year observation, this indicator decreased by 2.84 times (in 1991 it was 8.4 ‰), primarily due to the introduction of the latest perinatal medical technologies.

In the structural distribution of infants, who died at the age of 0–6 days in 2021, the weight category of less than 1500 g (49.28 %) prevails. Particular attention is paid to infants with normal birth weight (2500 g and more), who died at the age of 0–6 days (29.31 % of all deaths among this age).

The level of the proportional indicator of early neonatal mortality in the weight category of 1500 g and more for all years exceeds the corresponding level in the weight category of less than 1500 g. Only since 2017 this ratio has slightly changed. In 2021 it was 1.49.

According to the perinatal audit using the “Matrix-Babies” method, despite the positive dynamics (6.3 ‰ — in

2001, 3.87 ‰ — in 2010, 2.94 ‰ — in 2021) the proportional indicator of early neonatal mortality among Ukrainian babies with a birth weight of more than 1500 g exceeds the corresponding standard by 1.5 times, which may be due to deficiencies of obstetric care before and during childbirth, as well as neonatal care. Despite a significant reduction in the rate of early neonatal mortality in the weight category of 1500 g and more from 3.62 per 1000 live births and stillbirths in 2001 to 1.49, in 2020 its level still does not meet international standards.

According to WHO data, the actual level of early neonatal mortality of babies in Ukraine may be significantly underestimated. According to this method, if the weight category of newborns with a body weight of 1000–1499 g was less than 1 ‰, then the real level of early neonatal mortality in Ukraine may be higher than the actual one by almost 2 times, which may be due to deficiencies of obstetric care before and during childbirth and neonatal care. It is also possible to undercount early neonatal mortality: this is a part of unaccounted-for losses of live births and stillbirths, i.e. unregistered births [1, 8]. The potential for reducing the level of early neonatal mortality in this weight category depends on the quality of care for infants before discharge from the hospital.

A reserve for improving of Ukrainian children's health and reducing of perinatal losses, the formation of morbidity and disability of children should be an effective regionalized system of three-level neonatal care, with the creation of modernly equipped perinatal centers of the II–III level and the implementation of the modern technologies based on evidence-based medicine. A separate task is to restore the work of perinatal centers that suffered as a result of the war in Ukraine.

An important resource for reducing the level of infant and perinatal mortality in Ukraine and increasing the birth rate should be the stabilization of the sociopolitical state of the country and appropriate international assistance in restoring the health care system, aimed at improving of both the somatic and reproductive health of future parents, primarily mothers. It should form in them a conscious and appropriate attitude towards future parenthood and care for the newborn.

An important component is the resumption of work in the regions of the country “Youth Friendly Clinic” to ensure continuous educational teamwork of specialists in various fields with adolescents and young people to break bad habits and prevent risky sexual behavior and prevent sexually transmitted infections.

Currently all Ukrainian newborns are tested free of charge for 4 hereditary diseases: hypothyroidism, phenylketonuria, adrenogenital syndrome, and cystic fibrosis. Thus, it is extremely important for Ukraine to expand from 4 to 21 mandatory early neonatal screening programs for severe orphan diseases, but, unfortunately, this initiative of the government may be suspended due to the war. This screening program can work according to world standards only in the case of creating a state electronic information system for neonatal screening, because in Ukraine early diagnosis of orphan disease takes up to 2–3 weeks, unlike EU standards.

Only in the USA the full implementation of the prenatal screening program has led to a significant decrease in perinatal mortality of fetuses and newborns with congenital anomalies and a significant increase in early intrauterine mortality up to 24 weeks of gestation [12].

Undoubtedly, an important resource in reducing the infant mortality rate in Ukraine is the increase of the number of children who are breastfed under the age of 1 and the reduction in the amount of operative obstetric interventions in the physiological process of childbirth. It is also necessary to continue systematic work on improving the qualifications of the medical staff of women's consultations, maternity homes, and children's hospitals in order to master modern clinical protocols for providing care to pregnant women and newborns and providing them with the latest medical and diagnostic equipment.

Conclusions

In Ukraine after reaching a maximum in 2012 to 11.2 ‰, there has been a significant decrease in the birth rate by 47 ‰ in the last 8 years due to the deterioration of the socio-economic development of the country because of the pandemic and the ongoing war.

Infant mortality, perinatal mortality, early neonatal mortality, and stillbirth rates in Ukraine have more than halved in 30 years and are lower than in the CIS countries, but still, exceed those in the EU.

The downward trend was specific for all components of perinatal mortality; more for intranatal mortality, less for early neonatal mortality, whose share in the structure has increased in recent years, which requires improving the quality of medical care for newborns and antenatal care. The fact that early neonatal mortality rates in Ukraine may be underestimated due to shortcomings in the registration of live births and stillbirths is worrying.

The main causes of perinatal mortality in Ukraine were congenital malformations and conditions that appears during pregnancy and childbirth in women who give birth to children with very low and extremely low body weight, the specific share of which is increasing.

An effective way to reduce child losses in Ukraine during the last decade was the implementation of modern perinatal technologies to prevent pathological conditions of mothers and babies with extremely low and very low body weight, the creation of a network of perinatal centers in the regions of the country with the help of international aid with proper conditions for safe childbirth, timely diagnosis and treatment of congenital malformations and conditions arising in the perinatal period.

An important resource for reducing infant and perinatal mortality in Ukraine and increasing the birth rate will be the stabilization of the sociopolitical situation in the country and appropriate international assistance in restoring the health care system, aimed at improving both somatic and reproductive health of future parents, especially mothers, forming in them a conscious and proper attitude to future parenthood and care for the newborn.

The expansion of mandatory early neonatal screening programs from 4 to 20 is extremely relevant for Ukraine.

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Народжуваність, перинатальна смертність і малюкова смертність в Україні: еволюція з 1991 до 2021 року і сучасні ризики

Резюме. Україна є однією з найбідніших країн Європи, яка зараз зазнає російської агресії, і на тлі високої смертності останніми десятиліттями стабільно знижується народжуваність — на 47 %, а показники дитячої і перинатальної смертності залишаються одними з найвищих у Європі. Показники малюкової смертності, перинатальної смертності, ранньої неонатальної смертності і мертвонароджуваності в Україні за 30 років зменшилися більше ніж удвічі і є меншими, ніж у країнах СНД, але поки що перевищують аналогічні показники в країнах ЄС. Тренд до зниження був характерним для всіх складових перинатальної смертності; більше для інтранатальної смертності, менше — для ранньої неонатальної смертності, чия питома вага у структурі в останні роки зросла, що вимагає покращання якості надання медичної допомоги новонародженим і життя заходів щодо антенатальної охорони плода. Не може не турбувати факт можливого зниження показника ранньої неонатальної смертності в Україні через недоліки в обліку народжених живими і мертвонароджених. Уроджені вади розвитку та стани, що виникли в перинатальному періоді в дітей з дуже низькою та екстремально низькою масою тіла, домінують серед при-

чин перинатальної смерті в Україні. Ефективним шляхом зменшення дитячих втрат в Україні протягом останнього десятиріччя стало впровадження сучасних перинатальних технологій для запобігання патологічним станам у породіль і немовлят з екстремально низькою і дуже низькою масою тіла, продовження створення й відновлення мережі перинатальних центрів і належних умов для безпечних пологів у регіонах країни за допомогою міжнародної допомоги, своєчасної діагностики й лікування станів, що виникають у перинатальному періоді, і вроджених вад розвитку. Важливим ресурсом зниження дитячої і перинатальної смертності в Україні й підвищення народжуваності стане стабілізація соціально-політичної ситуації в країні та відповідна міжнародна допомога у відновленні системи охорони здоров'я, спрямована на покращання як соматичного, так і репродуктивного здоров'я майбутніх батьків, особливо матерів, формуючи в них свідоме й правильне ставлення до майбутнього батьківства й догляду за новонародженим.

Ключові слова: народжуваність; малюкова смертність; перинатальна смертність; мертвонароджуваність; перинатальні центри