

Predicting fertility, neonatal and perinatal mortality, and stillbirths for evaluation of the needs for perinatal care in the future post-war reconstruction of Ukraine

Tatiana A. Vezhnovets, Oleksandr V. Korotkyi, Vitalyi G. Gurianov, Valentin D. Paryi, Tetiana M. Orabina, Andrii O. Pysariev, Yurii V. Marushko

BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE

ABSTRACT

Aim: To predict trends in fertility, neonatal and perinatal mortality, and stillbirth rates to ascertain future perinatal care requirements during the post-war reconstruction in Ukraine.

Materials and Methods: The study uses the data from the Centre for Medical Statistics of the Ministry of Health of Ukraine, covering the years 2012 to 2022. The data analysis was by a univariate linear regression model. The quality of these models was evaluated using the coefficient of determination, R^2 .

Results: In 2022, the birth rate in Ukraine had declined to 2.5 times lower than that of 2011. The period was characterized by a notable increase in the incidence of premature births and in neonates with birth weights under 1000 grams and between 1000 to 2499 grams. While the neonatal mortality rate decreased by 3.7 times, there remains a statistically significant ($p < 0.05$) increase in the mortality rates of premature infants and neonates weighing less than 1000 grams. The stillbirth rate in Ukraine remains constant; however, it exceeds that of the European Union. Predictions indicate a rise in antenatal mortality and a reduction in both intranatal and perinatal mortality. As of 2022, the perinatal mortality rate in Ukraine made up 7.72 per 1000 live births, which is significantly higher than the rate in the European Union.

Conclusions: The optimization of the network of healthcare facilities and resources should be prioritized, in response to the reliable decline in the birth rate. This necessitates improvements in the medical care for premature and low birth weight infants, and efforts for preventing stillbirths.

KEY WORDS: fertility, stillbirth, neonatal mortality, perinatal mortality, perinatal care

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INTRODUCTION

Ensuring the availability and quality of health care is vital in Ukraine, even during health emergencies caused by Russian aggression. Throughout more than 23 months of war, the Government Portal reports damages of 1523 health care facilities by Russia, and destructions of 195 of them [1].

The joint commission of the Government of Ukraine, the World Bank and the European Commission estimated the preliminary damage to the health sector as of June 1, 2022, at \$1.4 billion [2]. The estimated cost for the total health sector recovery totals \$15.1 billion, including restoration of damaged infrastructure, covering for losses within the health sector, as well as enhancement of the access to critical health services [3]. In addition, the destruction of health care facilities and the occupation of the territories, have reduced access to medical care for women and children. This is expected to lead to increase in premature births, stillbirths, intrauterine infections among newborns, and

the incidence of underweight children, as the displaced women from the war zone experience stress, trauma, inadequate nutrition and limited access to specialized health care facilities. Sometimes they are forced to deliver in non-medical settings. The stillbirth rate is closely related, on the one hand, to the level of medical and economical development in the country, and the overall function of the health care system. Though, it is affected by the health of parents and maternal behaviour during pregnancy [4, 5].

In order to achieve the Sustainable Development Goals declared by the United Nations by 2030 [6], even under the challenges produced by Russian aggression, and during the period of post-war recovery, Ukraine is tasked with its healthcare transformation. This includes optimal structure and healthcare services reorganization, to provide the population with high-quality, safe, affordable healthcare, according to the population needs.

Therefore, the post-war reconstruction of the healthcare Ukraine requires optimal infrastructure, as well

as identification of necessary human, financial, and technical resources to achieve accessibility, safety, and quality of this service. This needs mathematical model prediction.

AIM

The aim of the study was to predict trends in fertility, neonatal and perinatal mortality, and stillbirths, to determine the needs for perinatal care in the future postwar period of Ukraine's reconstruction.

MATERIALS AND METHODS

The article examines the statistical data of Ukrainian healthcare institutions that provided perinatal care in 2012-2022, according to the reporting form 21 "Report on medical care for pregnant women, women in labour and women in childbirth in 20_". The analysis includes the following characteristics: fertility rate per 1000 inhabitants, percentage growth (decline) rate from 2012 to 2022 (%), neonatal mortality rate per 1000 births (0-28 days), early neonatal mortality rate (0-6 days) per 1000 births, stillbirth rate per 1000 births.

The calculation of the intensity coefficients was using resources of the State Statistics Service (<http://db.ukrcensus.gov.ua>), the Centre for Public Health of the Ministry of Health of Ukraine (<http://medstat.gov.ua>), the World Bank (<https://data.worldbank.org>), and UNICEF (<https://data.unicef.org>).

We developed a univariate linear regression model to analyze the data, and assessed its performance by the coefficient of determination, R^2 . The data were treated by the MedCalc® Statistical Software version 22.009 (MedCalc Software Ltd, Ostend, Belgium; <https://www.medcalc.org>; 2023).

RESULTS

Between 2012 and 2022, Ukraine experienced a significant reduction in the number of births, from 521,425 to 199,619. The period faced a significant decrease in the fertility rate, from 11.43 to 4.85 per 1000 people ($p < 0.001$) (Fig. 1).

The fertility rate decrease in Ukraine made up 57.6% over these years. In comparison, the World Bank data indicates that the global fertility rate decrease was 15% (from 20 to 17 births per 1,000 population), and within the European Union, the decrease was 10% (from 10 to 9 births per 1,000 population) during the same period [7]. A catastrophic decline in the birth rate was observed in Ukraine, especially when compared to global and EU averages, primarily attributed to the war with Russia

that began in 2014. Moreover, projections from a linear regression model suggest that by 2027, Ukraine's fertility rate could have been reduced by an additional 48.5% from its 2022 level, reaching as low as 2.5 births per 1,000 population ($R^2 = 0.98$, $p < 0.001$).

The perinatal care is provided in Ukraine through a network of municipal, private, or other (departmental) healthcare facilities. Between 2012 and 2021, the proportion of births in private and other (department) facilities increased from 1.42% to 2.11%. However, 2022 met a sharp decline to 1.41%, due to Russia's full-scale military aggression.

A significant indicator for perinatal care planning is the rate of preterm births. Between 2012 and 2022, the proportion of preterm births in Ukraine increased significantly from 4.5% in 2012 to 5.5% in 2022 ($p < 0.001$).

The regression analysis foresees that the proportion of preterm infants among newborns will climb to 5.97% by 2027.

The period from 2021 to 2022 was characterized by a significant decline in the percentage of full-term births of children with a birth weight of 3500 g, decreasing from 40.7% to 38.07%. Respectively, there was an increase in the proportion of neonates with a birth weight of up to 1000 g, from 0.25% to 0.33%. As for the newborns weighing 1000-2499 g, the proportion increased from 5.12% to 5.8% ($p < 0.001$, with statistical significance confirmed by the chi-square test).

In the period from 2012 to 2022, Ukraine showed a downward trend in neonatal deaths among newborns, dropping from 1545 to 414 cases (decrease -73.2%). The neonatal mortality rate also significantly decreased from 2.96 to 2.07 per 1000 births ($p = 0.003$) (Fig. 2).

According to the World Bank in 2021, the neonatal mortality rate in the European Union stood at 2.0 per 1,000 births, whereas in Ukraine, it was 2.24‰ [7]. Linear regression analysis projects a further significant reduction in the neonatal mortality rate in Ukraine by 17.4% by 2027, with a projected rate of 1.71 per 1,000 births ($R^2 = 0.81$, $p = 0.003$).

During the same decade, we observed an increase in the mortality rate of preterm infants (0-28 days) from 71.97% to 77.78% ($p = 0.014$). Additionally, the percentage of preterm infants weighing less than 1,000 g who died within the first 28 days rose from 33.8% in 2012 to 50.1% in 2022.

The period faced a decrease in the number of early neonatal deaths (0-6 days after birth) from 1,330 to 344 children, with a reduction rate of 74.1%. The early neonatal mortality rate significantly decreased from 2.55 to 1.72 per 1,000 births ($p = 0.003$) (Fig. 3).

According to the World Bank, in 2019, the early neonatal mortality rate within the European Union member states stood at 1.8 per 1,000 births, which marked a

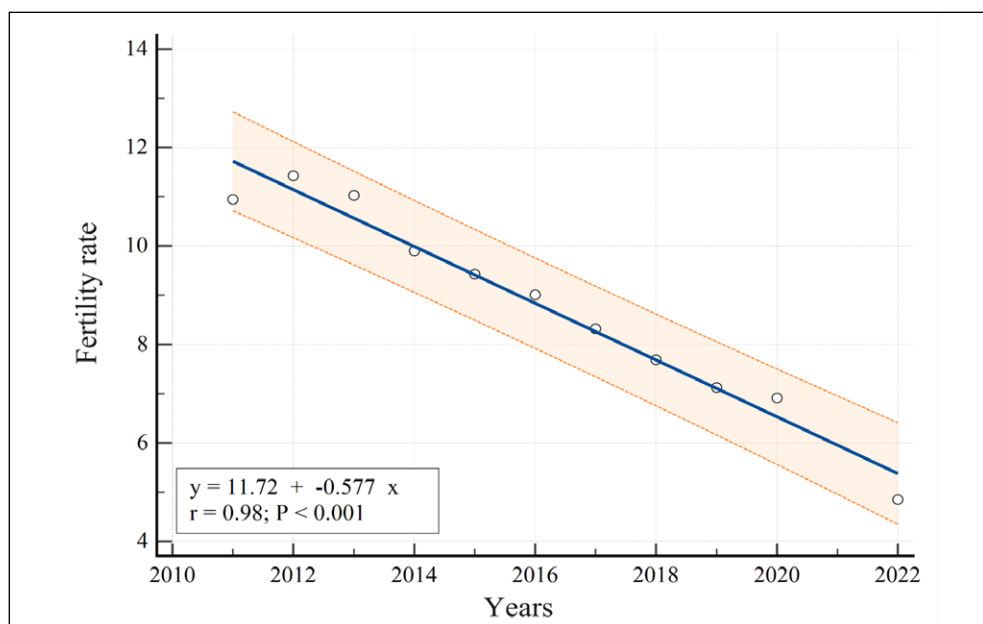


Fig. 1. Dynamics of the fertility rate per 1000 population in Ukraine in the period 2012-2022 (%).

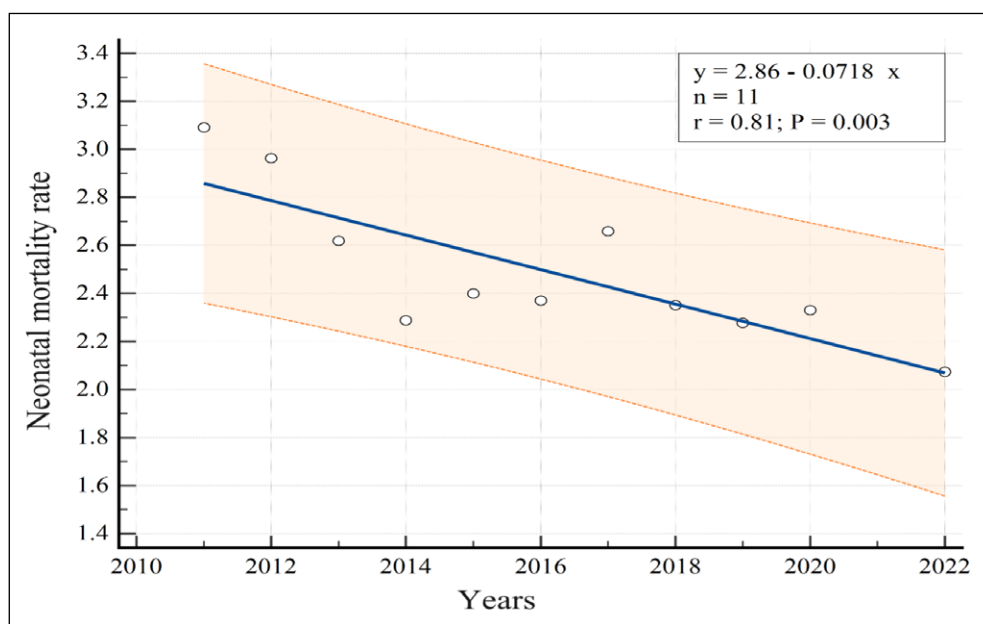


Fig. 2. Dynamics of the neonatal mortality rate per 1,000 births in Ukraine in the period 2012-2022 (%).

decrease of 2.17% from 1.84 per 1,000 births in 2012 [7]. In Ukraine, the early neonatal mortality rate in 2019 was 1.91 per 1,000 births, which is 5.8% higher than that in the European Union member states. According to Liisa Lehtonen et al., the deaths of newborns within the first 0-6 days makes up 73% of all newborn mortality [8]. In Ukraine, this proportion was higher, at 86.72% in 2012 and 84.36% in 2022, which exceeds the global averages.

Predictions from the linear regression model suggest that by 2027 the early neonatal mortality rate in Ukraine will decrease to 1.4 per 1,000 births ($R^2 = 0.8, p < 0.05$), which represents a 18.6% reduction compared to 2022.

From 2012 to 2022, the proportion of preterm infants who died within the first 0-6 day period increased significantly from 70.1% to 74.7% ($R^2 = 0.65, p < 0.05$).

Over the same period, Ukraine observed a 2.6-fold decrease in stillbirths, from 3,163 to 1,201 cases. Consequently, the stillbirth decreased by 16.7% from 6.03 to 5.98 per 1,000 births (Fig. 4), with the rate calculated per 1,000 live births and stillbirths. The significant decrease in the infant mortality rate in Ukraine was not observed in the period ($p > 0.05$).

According to UNICEF data in 2021, the global stillbirth rate was 13.9 per 1,000 births. At the same time, the European Union reported this rate in 2020 as 2.7 per 1,000 births. So, the coefficient in Ukraine is 2.3 times higher, compared to the countries of the European Union,

Projections from the linear regression model show that by 2027 Ukraine will have a steadily high stillbirth rate of 5.92 per 1,000 births ($R^2 = 0.09, p > 0.05$).

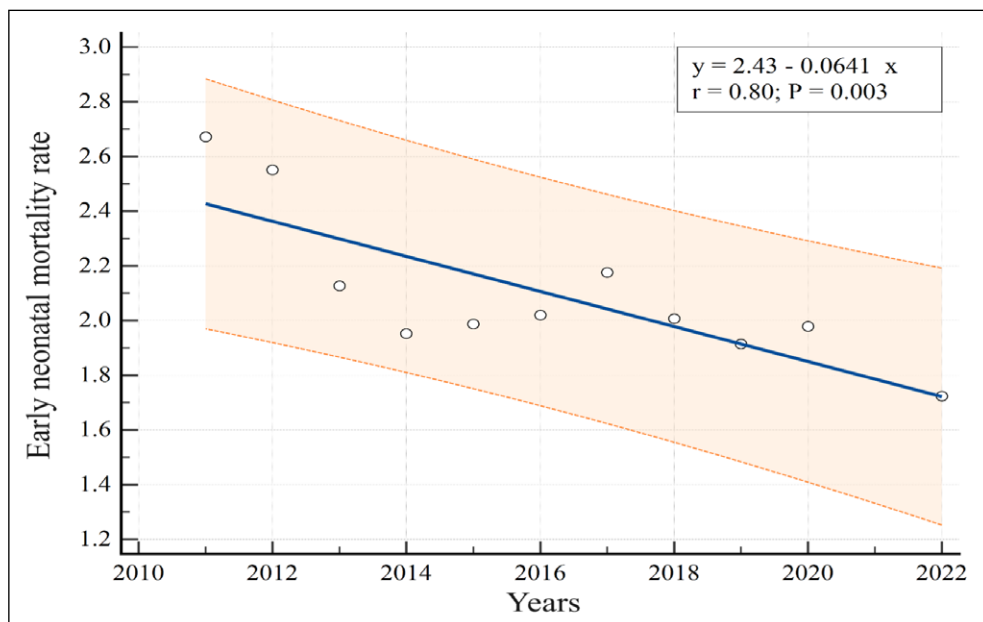


Fig. 3. Dynamics of the early neonatal mortality rate (0-6 days) per 1,000 births in Ukraine in the period 2012-2022 (‰).

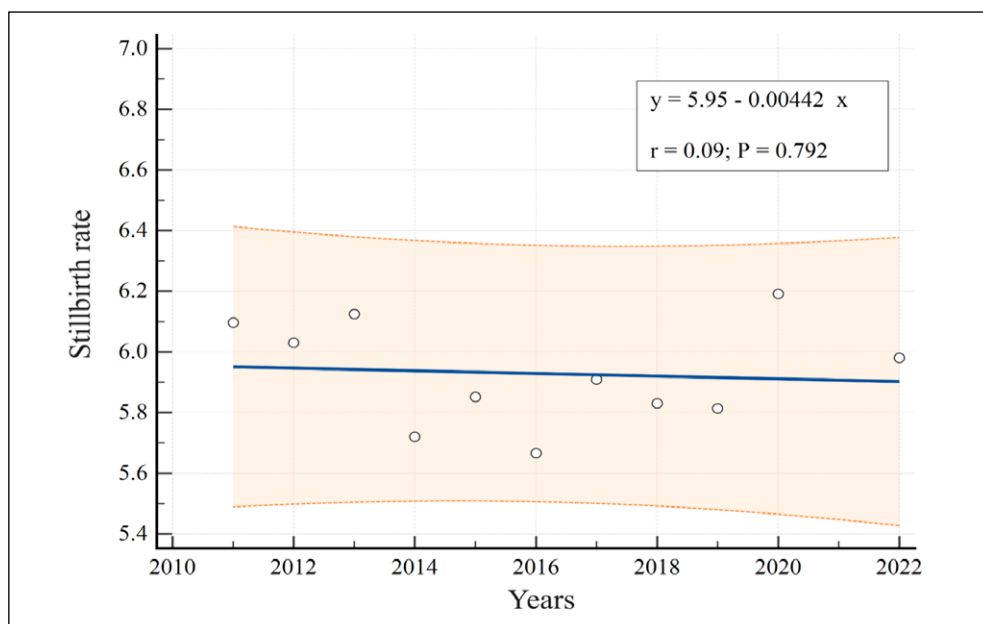


Fig.4. Dynamics of the stillbirth rate per 1,000 births in Ukraine in the period 2012-2022 (‰).

From 2012 to 2022, the proportion of premature stillbirths increased from 58.1% to 65.4%. According to the linear regression model, by 2027 Ukraine is expected to see a significant increase in the proportion of preterm stillbirths to 71.2% ($R^2=0.95$, $p<0.001$).

From 2012 to 2022, the number of fetal deaths in Ukraine from 22 weeks of gestation up to the labour diminished by 2.5 times, from 2,760 to 1,120 cases. However, during the same period, the antenatal mortality rate increased by 5.7%, from 5.26 to 5.58, per 1,000 live births and stillbirths (Fig. 5).

Further linear model analysis predicts, that by 2027, the antenatal mortality rate in Ukraine will increase by 23.6% to 7.3 ($R^2=0.7$, $p<0.05$).

In the period from 2012 to 2022, fetal deaths during

childbirth in Ukraine decreased, dropping 5-fold, from 403 to 81 cases. During the same period, the intrapartum mortality rate, which includes live and stillborn births, decreased by 48.1%, from 0.77 to 0.4 per 1,000 births (Fig. 6).

According to the predictions from a linear regression model, by 2027, the intrapartum mortality rate in Ukraine is expected to decrease by 55.0%, to 0.18 ($R^2=0.91$, $p<0.001$).

From 2012 to 2022, the perinatal mortality rate in Ukraine fell from 8.59 to 7.72 per 1,000 live births and stillborn births, or by 10.1% (Fig. 7).

According to the linear regression model, the perinatal mortality rate in Ukraine is expected to drop by 5.4%, to 7.3‰ by 2027 ($R^2=0.63$, $p<0.05$).

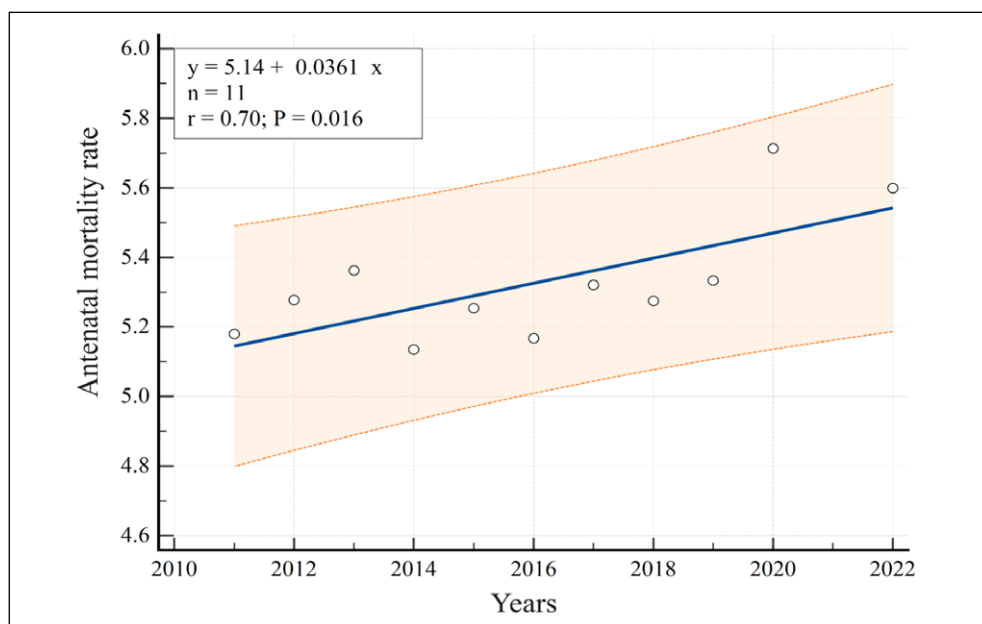


Fig. 5. Dynamics of the antenatal mortality rate per 1,000 live births and stillbirths in Ukraine in the period 2012-2022 (%).

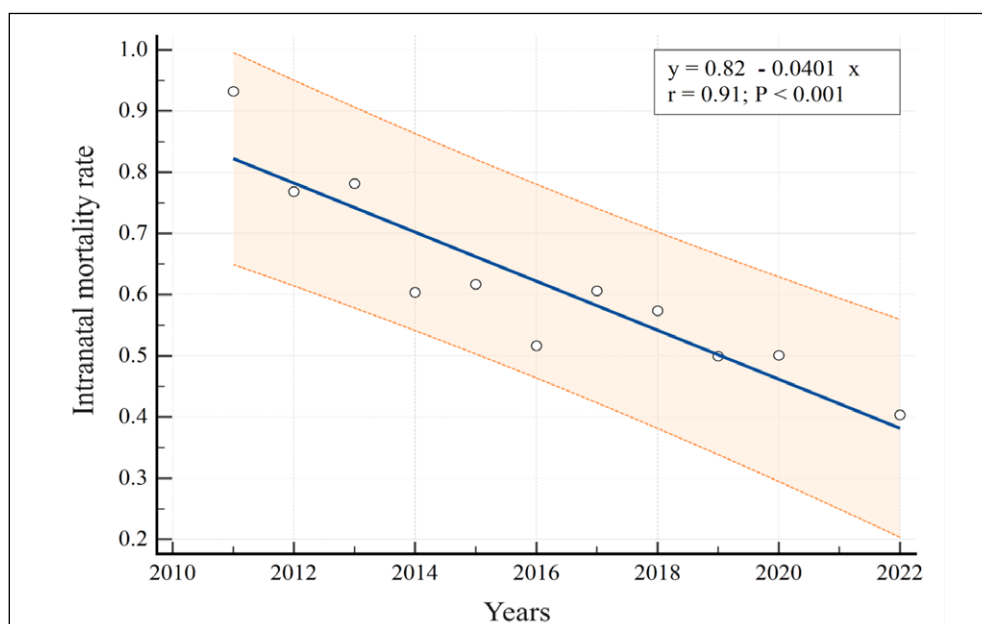


Fig. 6. Dynamics of the intrapartum mortality rate per 1,000 live births and stillbirths in Ukraine in the period 2012-2022 (%).

DISCUSSION

The analysis of the presented research results indicates significant challenges to the structuring and implementation of perinatal care in Ukraine.

Ukraine is experiencing a significant decrease in the fertility rate, with the births in 2022 dropping by 2.5 fold, compared to compared to 2011. Two years of war have further exacerbated the birth rate. It is predicted that Ukraine might have the lowest birth rate in the European Union. At the same time, the proportion of premature babies and newborns weighing less than 1,000 grams, and those weighing 1,000-2,499 grams is significantly increasing among newborns. The characteristics of newborns by weight and gestational birth age reflect the conditions of fetal development, and

serve an integral indicator of the woman’s reproductive health, the progression of pregnancy, and the mother’s quality of life. This value is objective by nature, and can be determined at the population level [4]. According to our study, a further increase in the number of these newborns is predicted, which requires special attention of pediatricians-neonatologists and certain technologies to ensure the high-quality perinatal care.

In Ukraine, between 2011 and 2022, there was a notable reduction in neonatal mortality, with a 3.7-fold decline. The neonatal mortality rate is projected to further decrease to 1.71 per 1,000 newborns in 2027. By this, Ukraine will comply with the UN Sustainable Development Goals, which stipulate no more than 12 deaths per 1,000 newborns by 2030 [7]. However,

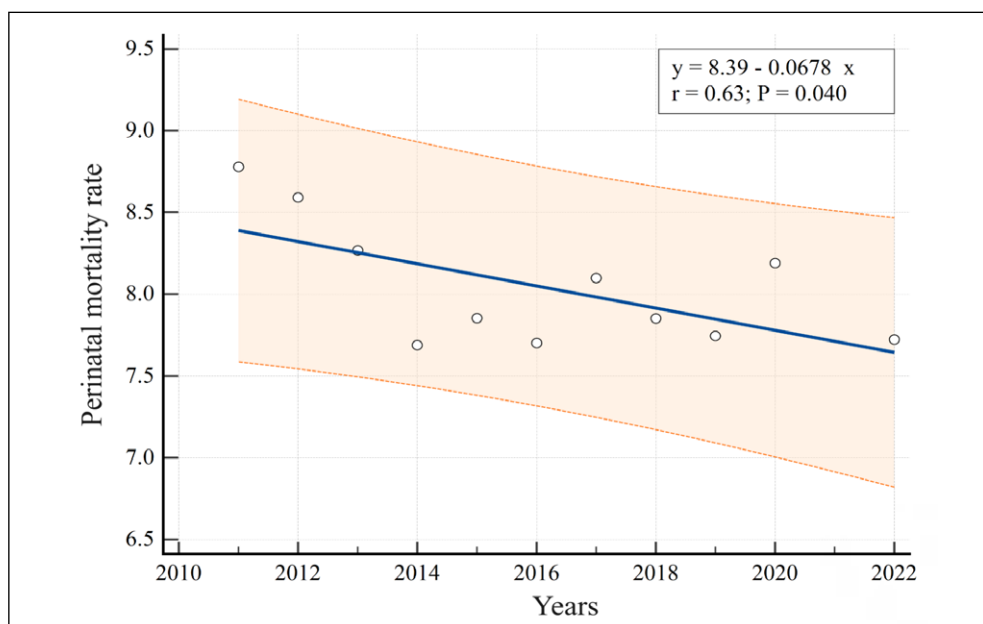


Fig. 7. Dynamics of the perinatal mortality rate per 1,000 live births and stillbirths in Ukraine in the period 2012-2022 (‰).

in Ukraine, there is still a significant upward trend in mortality of premature infants and those weighing less than 1,000 grams ($p < 0.05$).

According to our prognosis, the stillbirth rate remains stable in Ukraine, but exceeds that in the European Union. The main cause of stillbirth is preterm birth [9].

Approximately 15 million preterm infants are born worldwide every year, which indicates 11% of all births [10]. With about 1 million children dying before the age of five due to complications from preterm births, it makes a leading cause of death among children under 5, accounting for 18% of this age group deaths, and 35% of all neonatal deaths [10]. In addition, survivors of preterm birth may have lifelong disabilities, such as hearing and vision loss or learning disabilities [9, 11, 12]. The issue of preterm birth is of crucial importance for achieving the UN Sustainable Development Goals, which aim to eradicate all preventable deaths of newborns and children under the age of 5 by 2030 [7]. Various clinical, biological, environmental, and demographic factors affect the pregnancy outcomes. Maternal genetics, environmental exposure, stress level, nutrition quality, medical history, socioeconomic status, race and ethnicity, all play a role in determining the success of pregnancy [13]. However, the organization of perinatal care should be aimed at timely detection of threatening conditions during pregnancy in women. Addressing the issue of preventing preterm birth requires the perinatal service to emphasize the course

of pregnancy by providing effective pregnancy support, including at the primary care [14, 15].

Our study predicts a rise in antenatal mortality in Ukraine. Therefore, OBGYNs need to perform a timely assessment of antenatal risk during pregnancy management. The high rates of antenatal mortality risk are definitely associated with the mother's age, history of stillbirth, male sex of fetus, congenital anomalies, etc.

The study shows that intrapartum and perinatal mortality is expected to decrease in Ukraine. As of 2022, the perinatal mortality rate in Ukraine stood as 7.72 per 1,000 newborns, which is significantly higher than in the European Union. Among the EU member states, this figure was 5.3 per 1000 newborns in 2021 [16]. The perinatal mortality is a critical measure of quality of perinatal services in a country.

Therefore, during the post-war reconstruction period in Ukraine, emphasized increase in the birth rate, and improvement of the perinatal care are required.

CONCLUSIONS

The findings indicate the need to refine the health care infrastructure and resources of perinatal care, considering the steady decline in fertility, improving medical care for preterm and low birthweight infants, preventing stillbirths in women through effective monitoring of pregnancy, involving screening programs for the timely detection of congenital anomalies and prevention of extragenital pathology.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Oleksandr V. Korotkyi

Bogomolets National Medical University

13 Taras Shevchenko Blv., 01601 Kyiv, Ukraine

e-mail: korotkiy.md@gmail.com

ORCID AND CONTRIBUTIONSHIP

Tatiana A. Vezhnovets: 0000-0003-1156-8614 **A** **B** **D** **F**

Oleksandr V. Korotkyi: 0000-0002-5682-7926 **A** **B** **D**

Vitalyi G. Gurianov,: 0000-0001-8509-6301 **C**

Valentin D. Paryi: 0000-0003-4996-0056 **E**

Tetiana M. Orabina,: 0009-0000-6894-7389 **B**

Andrii O. Pysariev,: 0000-0002-9978-8031 **E**

Yurii V. Marushko: 0000-0001-8066-9360 **E**

A – Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article

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