Survival Analysis of Newborns with Low Birth Weight (Very and Extremely Low) in Kyrgyzstan

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Abstract: *Purpose*: The increase in the number of premature births in the Kyrgyz Republic was accompanied by the growth of the proportion of newborns with very low (VLBW) and extremely low birth weight (ELBW), which required a systematic analysis of the survival. The study aimed to determine the dynamics of survival among newborns in these groups for 2019-2024, accounting for regional differences.

Material and Methods: Kaplan-Meier curves and the log-rank test were used to assess statistical significance. Data, including medical records, reports from perinatal centres, and official statistics from the National Statistical Committee of the Kyrgyz Republic, were collected from all regions of the country, with an emphasis on regional differences in neonatal care infrastructure.

Results: The survival of newborns weighing 1,000 to 1,499 grams increased from 23.4% to 51.8%, accompanied by a reduction in early neonatal mortality from 48% to 26%. Among children weighing less than 1,000 grams, survival increased from 2.2% to 8.6%, at remained low. It was established that the most pronounced improvement was observed in the southern regions of the country, whereas in the northern and mountainous areas, the lag remained. The main factors driving positive dynamics were the expansion of antenatal care, the equipping of hospitals with intensive care equipment, and improvements in staff qualifications.

Conclusion: The practical significance of the study lies in the justification for further development of neonatal care infrastructure to reduce infant mortality and balance regional differences in Kyrgyzstan.

Keywords: Perinatal mortality, premature birth, antenatal care, neonatal intensive care, organisation of logistics, gastrointestinal tract.

INTRODUCTION

During 2000-2024, the number of premature births showed a steady upward trend, accompanied by an increasing proportion of infants belonging to the most clinically vulnerable categories of low-birth-weight newborns. In Kyrgyzstan, this vulnerability is exacerbated by substantial regional disparities in medical infrastructure, staffing, and access to specialised neonatal care. Persistently high mortality among these infants remains a critical medical and social issue for the country and the broader Central Asian region, where systematic evaluation of neonatal care quality is still limited. According to the National Statistical Committee of the Kyrgyz Republic [1], in 2021, the infant mortality rate was 12.3 per 1,000 live births, with premature babies accounting for a significant proportion of deaths. In 2023, in Kyrgyzstan, 3,600 newborns with low birth weight were registered, of which about 8% had ELBW, and survival in this group did not exceed 25% in perinatal centres in Bishkek.

Global studies emphasised the dependence of ELBW newborn survival on the level of economic development and medical infrastructure. For example, Ramaswamy *et al.* [2] showed that in low- and middle-income countries the survival of children with ELBW was 18-28%, whereas in countries with a developed healthcare system this figure reached 39%. This demonstrated the influence of high-tech medical support on neonatal outcomes. At the same time, Michaelis *et al.* [3] showed that, even with limited resources, adequate observation and feeding allowed children with VLBW to achieve normal growth parameters by 18 months of age. However, such cases remained isolated and did not reflect a systematic approach.

An analysis of risk factors carried out by Hussain and Adil [4] revealed that low educational level, poverty, malnutrition, and lack of antenatal observation

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significantly increased the likelihood of giving birth to a child with VLBW. These factors were widespread in Kyrgyzstan, where, according to UNICEF [5], about 21% of children under 5 years old in rural areas suffered from chronic malnutrition. Invasive fungal infections remained a serious threat to premature newborns. K. Baltazar-Braganza and Velasco-Aro [6] proved that the prophylactic use of fluconazole reduced mortality in children with a body weight of less than 1,500 g by 22% and reduced the risk of systemic mycoses threefold, which made this intervention feasible even in conditions of basic equipment.

The sex of the newborn also influenced survival: Qurashi [7] established that girls with ELBW had a higher chance of survival compared with boys (78.9% versus 68.6%; p=0.017), especially with a body weight of less than 750 g, which was due to the physiological maturity of the female organism. In addition, Yang *et al.* [8] showed that in South Korea, the survival rate of children with a body weight ≤500 g in high-tech departments reached 40.2%, whereas in institutions with limited resources, it was only 14.3%.

One accessible method for preventing complications was the use of probiotics. Deshmukh and Patole [9] demonstrated that probiotics reduced the risk of necrotising enterocolitis by 43% and overall mortality by 23%, findings that were especially relevant for countries with limited access to expensive medicines. Despite international research, data on the survival of newborns with VLBW and ELBW in Kyrgyzstan remained fragmentary. There was no systematic analysis of the influence of medical infrastructure and social policy on these indicators. The present work aimed to analyse the dynamics of survival among children with VLBW and ELBW in Kyrgyzstan for the period 2019-2024, taking into account factors influencing this indicator, such as the level of medical care, equipment availability, and staff qualifications. Additional tasks of the study were the assessment of the survival dynamics of new-borns with VLBW (1,000-1,499 g) and ELBW (<1,000 g) in Kyrgyzstan for 2019-2025, identification of regional differences in survival rates and the relation to neonatal care infrastructure, determination of the influence of antenatal care, hospital equipment and staff qualification on clinical outcomes, as well as the development of recommendations for improving the neonatal care system in the country.

MATERIALS AND METHODS

To conduct a comprehensive analysis of the survival dynamics of newborns with VLBW (1,000-1,499 g) and ELBW (less than 1,000 g) at birth in the Kyrgyz Republic for the period from 2019 to 2024, modern statistical methods widely used in medical biostatistics were applied. The primary method of analysis was the Kaplan-Meier method, which was highly efficient for time-to-event analysis with censored data, especially in studies of neonatal survival. The Kaplan-Meier method allowed evaluating the probability of survival as a function of the time from birth to the occurrence of a specific outcome - death or hospital discharge. This was especially important in the study of newborns, since a significant proportion of patients could be discharged before the event or transferred to another institution, requiring the inclusion of censored observations.

To assess the statistical significance of differences between groups by years of application and to compare survival across different periods, the log-rank test, also known as the Mann-Whitney test for survival, was used. This test allowed comparing survival curves built using the Kaplan-Meier method and revealed reliable differences between temporal subgroups at the $p<0.05$ level. The choice of these methods was determined by their recognition in international scientific practice and by their proven validity in analyzing survival in high-risk populations.

The analytical cohort included all live-born infants registered in the Kyrgyz Republic between 2019 and 2024 with a documented birth weight of 500-1,499 g and a gestational age of 22-32 weeks. These parameters were selected in accordance with national reporting standards harmonised with WHO recommendations. Only cases with complete information on birth weight, gestational age, survival status (death or discharge), and the corresponding dates required for time-to-event analysis were retained. Infants with congenital anomalies incompatible with life, records with ambiguous live-birth status, and duplicated entries referring to transfers from other territories were excluded. Missing data were assessed before statistical processing: cases lacking essential time-dependent variables, such as the date of death or discharge, were removed to avoid bias in Kaplan-Meier estimates. Records with incomplete information on secondary variables, including antenatal corticosteroid exposure, delivery mode, or transport availability, were retained for descriptive analysis but were not included in subgroup comparisons requiring these parameters. Examination of the missingness pattern did not reveal systematic associations with survival outcomes, ensuring that the final analytical dataset remained representative of the national cohort.

Based on the data, survival curves were built for subgroups of newborns with VLBW and ELBW, providing a clear representation of the dynamics of indicators over the study period. The division into groups by birth weight contributed to a more detailed analysis of survival and the identification of possible trends associated with differences in clinical approaches, the level of medical care, and the organisation of perinatal care.

The study covered the entire territory of the Kyrgyz Republic, including all administrative regions: Osh, Batken, Jalal-Abad, Chuy, Issyk-Kul, Naryn, and Talas regions, as well as the capital - the city of Bishkek. Particular attention was paid to the activities of the Osh City Clinical Hospital, which served as the Perinatal Centre for the southern region of the country and accounted for a significant proportion of premature births. The analysis included children with a body weight of 500 to 1,499 g, born at a gestational age of 22 to 32 weeks, registered as live-born under the rules, as recommended by the World Health Organisation [10]. The lower limit of 500 g was chosen because, since 2015 in Kyrgyzstan, following World Health Organisation standards, such infants have been considered potentially viable and cared for, including in the ELBW group, all those weighing up to 1,000 g. Within the ELBW group, a subgroup of ultra-extremely low birth weight (micro-preemies) - newborns weighing less than 500 g or even less than 400 g - was distinguished, who required especially intensive care due to extreme immaturity. The gestational age of 22 weeks was chosen because the World Health Organisation defined this period as the minimum for registering live births, and the upper limit of 32 weeks corresponded to the typical term for newborns with VLBW and ELBW, covering the most vulnerable group of premature infants. Children were considered live-born if they showed signs of life such as breathing, heartbeat, umbilical cord pulsation, or voluntary movements.

Data collection was carried out from various sources: medical records of new-borns stored in the archives of maternity hospitals and perinatal centres, annual reports of the Osh City Clinical Hospital, official statistics of the National Statistical Committee of the Kyrgyz Republic [1], as well as information provided by civil registry offices, including data on mortality within the first three months of life. Licensed software, SPSS Statistics version 25.0, was used for data processing and analysis, ensuring high calculation accuracy, the ability to build survival curves, and the conduct of intergroup analyses. Contextual analysis of the obtained data was accompanied by the study of legal acts that influenced the organisation of neonatal care. In particular, the provisions of Resolution of the Government of the Kyrgyz Republic No. 748 "On Approval of the Regulation on the Procedure for Registration of Civil Status Acts in the Kyrgyz Republic" [11] were taken into account. These documents had a significant impact on the methodology for registering and managing prematurely born children, which was also considered when interpreting the results of the survival analysis.

This study aligned with the ethical principles of research, including anonymity, confidentiality, and beneficence. Ethical approval of the study was obtained from the Osh City Clinical Hospital with No. RA-787. Because the study combined records from multiple regional sources, all data were standardised using a unified extraction protocol that aligned birth weight, gestational age, and outcome definitions with national WHO-based reporting rules. Before creating the final dataset, regional files were cross-checked for duplicate entries, inconsistent dates, and implausible values. In cases of discrepancies between medical records and registry data, priority was given to the more complete clinical source. Additional verification was conducted for regions with limited documentation to ensure that variations in data quality did not distort interregional comparisons or the survival estimates.

RESULTS

A comprehensive analysis of the survival of newborns with VLBW (1,000-1,499 g) and ELBW (less than 1,000 g) in the Kyrgyz Republic for the period from 2019 to 2024 identified both national trends and regional differences, reflecting the availability and effectiveness of perinatal care.

The total number of live births in the country during the period under review varied from 152,000 to 165,000 annually. The average proportion of newborns weighing less than 1,500 g was about 1%, with slight fluctuations between 0.9% and 1.1%, corresponding to approximately 1,390-1,610 cases per year [1]. The data obtained confirmed a steady increase in both the absolute number of newborns in this weight category and the relative share of this weight category in the birth structure. In particular, if in 2019, 1,392 newborns weighed less than 1,500 g, then in 2024, there were already 1,614. The growth of these indicators was accompanied by improvements in recording and

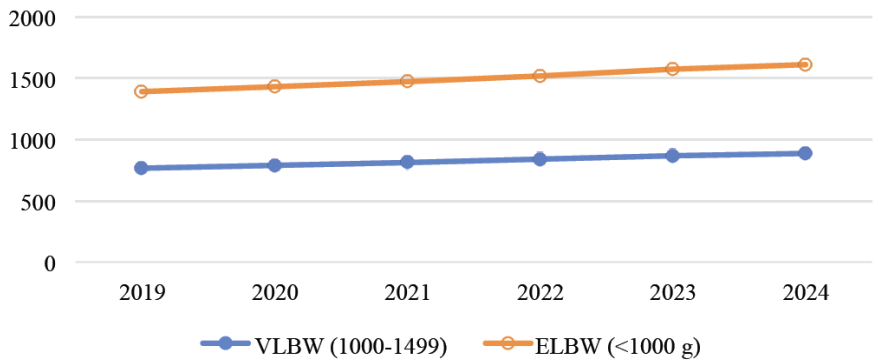

Figure 1: Dynamics of the number of newborns with a body weight of less than 1,500 g in the Kyrgyz Republic (2019-2024). Source: created by the authors.

registration quality, as well as the introduction of national protocols aligned with World Health Organisation practices for the care of low-weight and preterm infants. The division into VLBW and ELBW groups was based on medical documentation and classifications approved by the World Health Organisation [10]. In the total cohort of newborns weighing less than 1,500 g, about 55% weighed 1,000-1,499 g, and the remaining 45% weighed less than 1,000 g. This ratio remained stable throughout the entire observation period. Thus, in 2019, there were 766 cases of VLBW and 626 cases of ELBW; in 2024, 888 and 726, respectively (Figure **1**).

Survival indicators showed a clear positive trend, particularly in the VLBW group. Survival among infants weighing 1,000-1,499 g increased from 23.4% in 2019 to 51.8% in 2024, with the most rapid gains observed in 2020-2021. This improvement corresponded with broader use of modern neonatal intensive care practices, expanded antenatal corticosteroid coverage and better-equipped facilities. In contrast, survival among ELBW infants rose from 2.2% to 8.6% over the same period, remaining within single-digit values and reflecting ongoing limitations in resources and clinical capacity for this highly vulnerable group.

Given the high degree of immaturity of physiological systems in these newborns, effective therapy required a comprehensive approach, including specialised equipment, a multidisciplinary team, continuous condition monitoring, and long-term follow-up (Figure **2**). The Mann-Whitney criterion was used to compare the median survival time between the VLBW and ELBW groups. The results showed significant differences ($U=11,870$, $p<0.001$): the median survival for VLBW was 28 days (IQR: 7-28), for ELBW, 3 days (IQR: 1-7). This emphasised the higher vulnerability of ELBW children in the early neonatal period. Spearman's correlation analysis revealed a moderate positive correlation between VLBW survival and ACS use ($r=0.64$, $p<0.01$) and a weak correlation for ELBW ($r=0.35$, $p=0.045$). The availability of neonatal transport also correlated with survival ($r=0.58$ for VLBW, $r=0.42$ for ELBW, $p<0.05$), highlighting the importance of logistics.

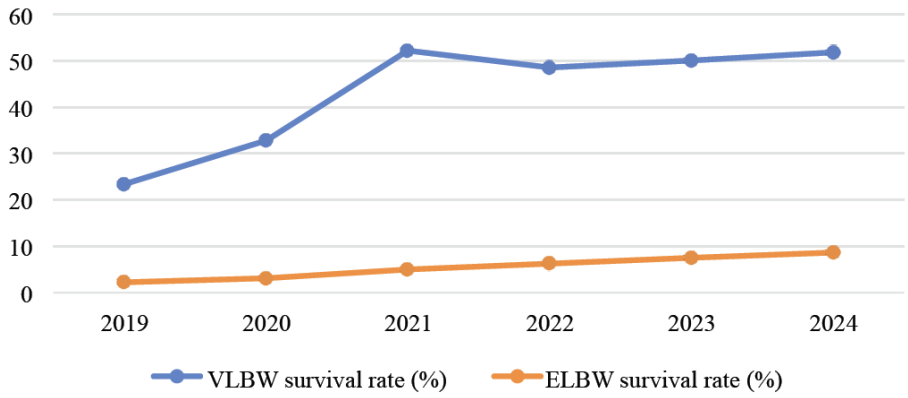

Figure 2: Dynamics of survival of newborns with VLBW and ELBW in the Kyrgyz Republic (2019-2024). Source: created by the authors.

Neonatal mortality within the first 28 days declined over the study period, most markedly in the VLBW group. Early mortality (0-7 days) among infants weighing 1,000-1,499 g fell from 48% in 2019 to 26% in 2024. Among ELBW infants, this indicator also decreased but remained consistently high, dropping from 86.9% to 68.5%. Late neonatal mortality (8-28 days) decreased in the VLBW group (from 21.9% to 13.0%). In contrast, in the ELBW group, it increased slightly (from 8.6% to 16.1%), likely reflecting improved early survival but ongoing limitations in prolonged care. The Mann-Whitney test confirmed significant differences in early mortality between the groups ($U = 9,870$, $p < 0.001$).

To enhance statistical transparency, 95% confidence intervals and p-values were added to the main survival comparison. By 2024, survival to 28 days among infants with VLBW (1,000-1,499 g) reached 51.8% (95% CI: 49.9-53.7), whereas survival in the ELBW group (<1,000 g) was 8.6% (95% CI: 7.6-9.7). The difference between the two survival curves was statistically significant according to the log-rank test ($\chi^2 = 412.6$, $p < 0.001$). These findings were consistent with the Mann-Whitney comparison of median survival, which also showed a marked disparity ($U = 11,870$, $p < 0.001$), confirming substantially higher mortality risk in the ELBW group.

Regional analysis showed that the highest survival indicators were traditionally recorded in the southern part of the country, particularly in the Osh region, where the largest perinatal centre operated. Here, survival rates among VLBW by 2024 exceeded 60%, and among ELBW reached 11.3%. In the northern regions, such as Chui and Issyk-Kul, moderate indicators were observed, especially in cities with well-developed infrastructure (e.g., Bishkek and Karakol). At the same time, in remote and mountainous regions (Naryn and Talas regions), survival rates remained significantly below the national average: less than 40% among VLBW and less than 6% among ELBW. The Mann-Whitney test confirmed regional differences ($U=8,760$, $p<0.001$ for VLBW; $U=7,320$, $p=0.003$ for ELBW). These differences were probably due to logistical difficulties, a lack of equipment, and limited access to timely neonatal care. In some cases, survival depended on the availability of emergency transportation to regional centres, which was not always provided within critical time windows.

Antenatal losses also showed a favourable trend. The proportion of stillbirths among infants weighing under 1,500 g declined from 31.5% in 2019 to 27.7% in 2024. Although peak values exceeding 42% were recorded in 2020-2022, subsequent improvements in prenatal monitoring and the broader use of interventions to prevent preterm birth contributed to a steady reduction. As foetal death is frequently linked to late detection of hypoxia, infection, or hypertensive complications, enhanced perinatal surveillance played a central role in these improvements. Comparison of survival dynamics between the two groups - VLBW and ELBW - confirmed that the main successes during the analysed period were achieved precisely among children with VLBW. The introduction of protocols for nursing newborns weighing 1,000-1,499 g, the organisation of specialised beds in maternity hospitals and perinatal centres, and the use of less invasive methods of respiratory support and early enteral feeding significantly influenced clinical outcomes. The positive effect was enhanced when hospitalisation was

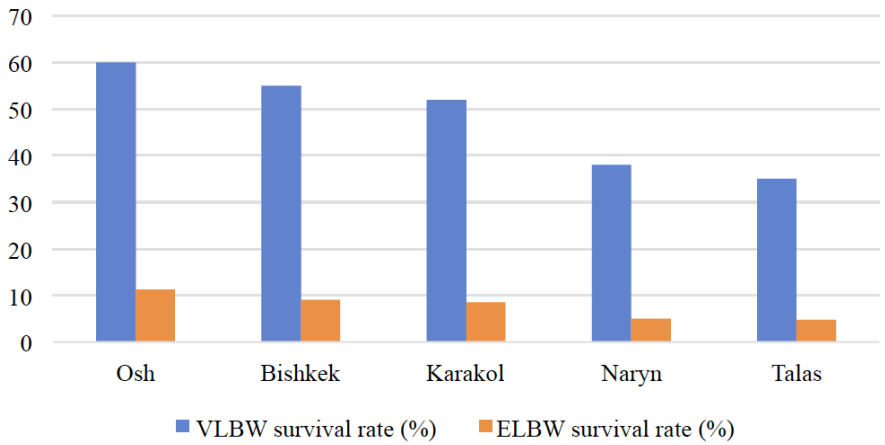

Figure 3: Comparative survival of newborns with VLBW and ELBW by regions of the Kyrgyz Republic (2024).
Source: created by the authors.

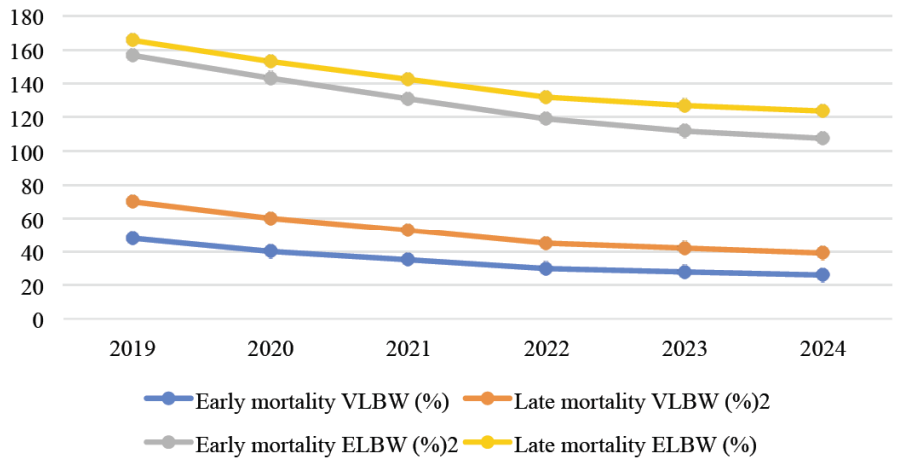

Figure 4: Neonatal mortality indicators among VLBW and ELBW (2019-2024).

Source: created by the authors.

possible in third-level institutions, where the level of technical support and staff qualifications met minimum international standards (Figure **4**).

Progress in the ELBW group remained limited. Despite greater availability of essential equipment, the main barrier was the extreme physiological immaturity of infants under 1,000 g, who faced high risks of trauma, intraventricular hemorrhage, and respiratory failure from the moment of delivery. Many district and some regional hospitals lacked the capacity for prolonged ventilation, acid-base monitoring, and correction of metabolic disturbances, which further constrained outcomes. Although Kyrgyzstan gradually adopted World Health Organisation [10] standards for the care of infants weighing 500 g or more from 2020 onward, nationwide implementation was hindered by geographic, economic, and staffing constraints. Nevertheless, the introduction of prenatal consultation systems in three pilot regions in 2021 improved the routing of high-risk pregnancies to third-level facilities.

Further analysis revealed significant impacts on survival from factors such as gestational age, the presence of ACS therapy, mode of delivery, and the timing of the child's transfer to the intensive care unit. In cases where pregnancy termination occurred at less than 28 weeks, and there had been no prior preparation, survival was minimal, especially among ELBW. Conversely, when the woman was admitted to the hospital 12-24 hours before delivery, and a course of dexamethasone or betamethasone therapy was given, survival indicators in the VLBW group increased by 8-12% compared to the general figures of the same year. In addition, delivery by planned caesarean section at foetal weight <1,200 g demonstrated better survival compared to vaginal delivery, especially in institutions where the operation could be performed with minimal delay. Another critical factor was the availability of neonatal transport within the first 3 hours of life. In large centres such as Bishkek, Osh, and Jalal-Abad, a neonatal transport system was deployed, allowing the child to be transferred to a specialised unit within the "golden hour". In areas where such an opportunity did not exist, the survival rate of newborns requiring urgent care decreased by 15-20%. By 2024, the transport system was improved in six regions of the country, but full national coverage had not yet been achieved.

The Kaplan-Meier curve for VLBW newborns in 2014 showed that the most significant decline in survival probability occurred during the first 7 days of life, after which the rate of decrease slowed considerably. Already by the first day of observation, the likelihood of survival was 90%, by the third day, 80%, and by the seventh day, 60%, which indicated high early neonatal mortality in this cohort. Subsequently, the rate of decline in survival probability slowed: by day 14, this indicator was 50%, by day 21, 35%. On day 28, the likelihood of survival reached 23.4%, which corresponded to the final data of the study. The dynamics of survival probability demonstrated the typical pattern for preterm infants, with the greatest losses in the early postnatal period and a gradual slowing of mortality rates in the late neonatal period (Figure **5**).

The data obtained during the study also allowed the conclusion that interregional inequality is gradually decreasing. If in 2019 differences in survival between the southern and northern regions reached 12-15% in

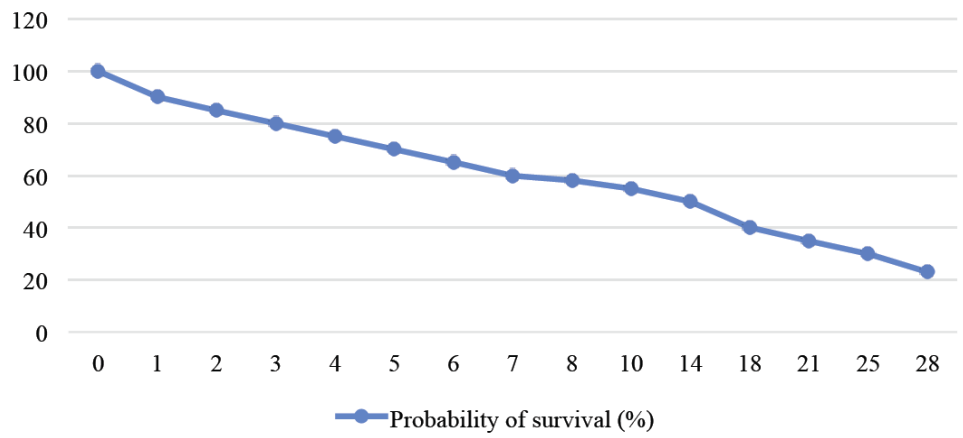

Figure 5: Kaplan-Meier survival curve for newborns with VLBW in the Kyrgyz Republic.
Source: created by the authors.

the VLBW group, then by 2024 this gap had decreased to 5-6%. In the ELBW group, differences remained more pronounced, but here too there was a trend towards levelling out. These changes were primarily associated with the implementation of the national perinatal care strategy and the inclusion of neonatal mortality issues in the Ministry of Health's priority agenda. The overall picture, based on six years of observation, showed that Kyrgyzstan achieved significant success in caring for VLBW newborns. Survival in this group more than doubled, antenatal losses and early neonatal mortality decreased significantly, and geographical differences became less pronounced. At the same time, the problem of survival of newborns weighing less than 1,000 g remained relevant and required further systemic steps - both in terms of technical re-equipment of maternity facilities and in the training of specialists in neonatal intensive care. In total, over the period 2019-2024 in the Kyrgyz Republic, 8,997 newborns weighing less than 1,500 g were registered. Of these, about 5,010 belonged to the VLBW category, and 3,987 belonged to the ELBW category. Overall survival in the VLBW group was 41.0%, and in the ELBW group, 6.6%. These figures reflected both the achievements and the limits of the existing healthcare system. Continued work in this direction would not only improve perinatal outcomes but also bring survival indicators closer to global target benchmarks.

DISCUSSION

Nutritional and maternal health factors played an essential role in shaping survival outcomes and require explicit consideration within the context of child health and nutrition. Maternal malnutrition, which remains prevalent in several regions of Kyrgyzstan, contributes to intrauterine growth restriction, reduced placental transfer of essential micronutrients, and higher rates of preterm delivery. These deficiencies directly affect the physiological resilience of VLBW and ELBW infants and partly explain regional variations in survival. The study period also highlighted the importance of early and structured feeding protocols. Facilities with established guidelines for initiating minimal enteral nutrition, advancing feeds in a stepwise manner, and monitoring tolerance reported lower rates of late neonatal mortality, particularly among VLBW infants.

Evidence from international research demonstrates that early enteral feeding and human milk fortification improve weight gain, reduce sepsis risk, and shorten hospitalisation, underscoring the need for broader implementation of such protocols in Kyrgyzstan. Emerging approaches - including probiotic administration to support gut colonisation and reduce the risk of necrotising enterocolitis - represent low-cost interventions with the potential to improve outcomes in resource-limited settings. While probiotics were not systematically used during the study period, their integration into neonatal nutrition strategies could represent an important direction for future national guidelines. Taken together, these findings highlight that strengthening maternal nutrition, optimising feeding practices, and incorporating evidence-based microbiome-supportive interventions constitute essential components for further improving survival among high-risk preterm infants in the country.

A major contributor to improved outcomes in the VLBW group was the introduction of evidence-based nursing protocols, including antenatal corticosteroids (ACS), less-invasive respiratory support, and early enteral feeding. A Chinese study demonstrated that a

single ACS dose improved postnatal growth, initiated earlier feeding, and reduced the need for ventilation among infants at 28-32 weeks' gestation [12, 13]. Kyrgyzstan observed a comparable effect, with ACS administered 12-24 hours before delivery improving VLBW survival by 8-12%. However, a German retrospective analysis showed that when the interval between ACS and delivery exceeded 7 days, respiratory complications increased significantly, including a daily 4.5% increase in ventilation requirements and a 5% increase in surfactant use [14, 15]. In Kyrgyzstan, such delays were common in mountainous regions like Naryn and Talas, reducing the full potential impact of ACS and underscoring the need to optimise logistical pathways for timely administration.

Regional disparities in access to high-tech neonatal care substantially influenced survival outcomes. A national cohort study from England demonstrated that ACS reduced mortality from 32.3% to 18.7%, yet significant North-South differences persisted, particularly among ELBW infants [16]. A similar pattern was observed in Kyrgyzstan: although the interregional gap in VLBW survival narrowed from 12-15% in 2019 to 5-6% in 2024, outcomes remained highest in the south - especially in Osh, where VLBW survival reached 60% - and lowest in northern and high-altitude regions such as Naryn and Talas (<40% for VLBW; <6% for ELBW). These differences reflected logistical constraints, limited equipment, and shortages of qualified personnel, and despite the introduction of prenatal consultation systems, their impact remained incomplete in remote areas.

Progress among ELBW infants was more modest. Survival increased from 2.2% to 8.6%, yet remained markedly lower than in countries with stronger neonatal infrastructure. A Turkish study reported survival below 33% for infants <750 g due to severe respiratory and infectious complications [17], and comparable causes dominated in Kyrgyzstan. Although early mortality in the ELBW group declined from 86.9% to 68.5% by 2024, insufficient availability of multidisciplinary teams and limited respiratory and metabolic support continued to restrict outcomes. Evidence from South Korea showed that mortality increased with a higher number of beds per physician, while at least two neonatologists per shift significantly improved survival [18] - a standard that is often unmet in many Kyrgyz regions, where a single neonatologist usually supervised up to ten beds.

Low-cost interventions also played an important role. An Ethiopian study showed that hypothermia quadrupled mortality risk and lack of kangaroo care nearly tripled it [19, 20]. In Kyrgyzstan, the introduction of kangaroo care in Osh and Chui from 2021 helped reduce late neonatal mortality in the VLBW group. However, effects in the ELBW group were modest due to physiological immaturity and limited staff expertise.

Effective routing of high-risk pregnancies further influenced outcomes. A systematic review found that regionalised perinatal care reduced perinatal mortality by 50% and neonatal mortality by 25% [21 - 23]. However, neonatal transport remained a persistent challenge in Kyrgyzstan. Without specialised transport, survival decreased by 15-20%. International evidence underscores the impact of inadequate transport: in Bangladesh, lack of monitoring and oxygen increased mortality by 12.3% [24]; in Bosnia, only 19.5% of infants were transferred within the recommended four-hour window [25]; and in Italy, poor organisation resulted in transport overload in several regions [26]. By 2024, Kyrgyzstan had established neonatal transport in six regions, but access in mountainous areas remained limited, particularly affecting ELBW infants.

The reduction of antenatal losses from 31.5% in 2019 to 27.7% in 2024 indicated improved quality of prenatal monitoring and broader use of preventive measures, such as threatened miscarriage therapy and intra-amniotic interventions. An Iraqi study showed that more than four doctor visits during pregnancy reduced the risk of early neonatal death more than twofold, especially with timely diagnosis of obstetric complications [27, 28]. In Kyrgyzstan, enhanced prenatal surveillance, especially in the southern regions, contributed to a reduction in antenatal losses. However, an increase in late neonatal mortality in the ELBW group (from 8.6% to 16.1%) indicated problems in the stage of long-term nursing. A Chinese study showed that improved organisation of care, including ventilation support and thermal provision, reduced complications by 13%, but required a systematic team and staff training [29, 30]. In Kyrgyzstan, late neonatal mortality in the ELBW group was often associated with sepsis, severe comorbidities, and insufficient provision of long-term care. A Japanese study revealed that surgical treatment later in the course improved prognosis, but early complications in the first 10 days remained critical [31 - 33]. An analysis in the USA showed that in 80% of fatal cases after sepsis, children had severe comorbidities and were transferred to palliative care [34]. In Kyrgyzstan, the absence of

multidisciplinary teams and personalised protocols limited the potential for long-term nursing care. A Chinese predictive model, based on Apgar scores, FiO_2, and body weight (AUC=0.83), enabled identification of vulnerable patients in the first 24 hours of life [35 - 37]. In Kyrgyzstan, such models had not yet been applied, but the introduction could improve early diagnosis and outcome prediction.

A comprehensive approach, including technical re-equipment of hospitals, training of medical personnel, optimisation of routing, and the introduction of unified clinical protocols, remained the only way to sustainably improve the survival of newborns with VLBW and ELBW [38 - 42]. The Kyrgyz Republic demonstrated significant progress, especially in the VLBW group, where survival more than doubled and the interregional gap decreased. However, caring for ELBW children required further effort, including expanded access to intensive care, training specialists, and developing a neonatal transport system. The data for 2019-2024 served as an essential basis for planning the next stage of reforms in neonatal care aimed at reducing infant mortality and equalising regional differences.

Policy implications emerging from the findings point to the need for a coordinated national strategy that embeds sustainable perinatal nutrition and healthcare equity into long-term health planning. Strengthening maternal nutrition programmes - particularly in regions with high levels of food insecurity - would reduce the incidence of intrauterine growth restriction and improve the resilience of preterm infants at birth. Ensuring equitable access to evidence-based feeding protocols, human milk banks, and fortification practices across all levels of care is essential to narrowing the survival gap between urban centres and remote mountainous regions. Similarly, investment in stable supply chains for neonatal nutritional products, including preterm formula, fortifiers, and probiotics, would contribute to sustainable improvements in postnatal growth and infection prevention. Equitable distribution of trained neonatal staff, transport resources, and modern equipment must accompany these efforts to ensure that nutritional and medical benefits reach the most vulnerable populations. Integrating these priorities into national perinatal policies would support a more resilient healthcare system and promote long-term reductions in regional disparities in neonatal outcomes.

CONCLUSIONS

This study enabled a comprehensive assessment of the dynamics of survival among newborns with VLBW (1,000-1,499 g) and ELBW (<1,000 g) in the Kyrgyz Republic from 2019 to 2024. During these years, the survival of children with VLBW more than doubled - from 23.4% to 51.8%. Substantial progress was due to comprehensive improvements in perinatal care: the introduction of modern nursing protocols, the expansion of antenatal therapy, including the use of corticosteroids, the development of neonatal services and systemic training of medical personnel. Thus, the use of ACS increased survival in the VLBW group by 8-12%, especially when administered 12-24 hours before delivery. A significant reduction in early neonatal mortality (within the first seven days) was also observed - from 48% to 26%, and late (8-28 days) - from 21.9% to 13%. In children with ELBW, survival increased from 2.2% to 8.6%. However, indicators remained low due to extreme immaturity, limited availability of intensive care and a shortage of appropriate equipment. Early mortality decreased from 86.9% to 68.5%, but late mortality, on the contrary, increased from 8.6% to 16.1%, which indicated insufficient conditions for long-term and stable care for this vulnerable group. This also pointed to the need for expanded rehabilitation and post-neonatal support programmes, especially in rural and hard-to-reach areas.

Regional analysis revealed significant differences. In the southern regions, especially in Osh, where a large perinatal centre operated, VLBW survival reached 60% and ELBW survival reached 11.3%. In the northern and high-altitude regions, such as Naryn and Talas, these indicators were significantly lower, less than 40% and less than 6% respectively. The main reasons were a shortage of equipment, qualified staff and limited access to specialised transport. The introduction of a system of prenatal consultations and the routing of pregnant women to third-level institutions increased survival by 15-20% in regions with developed infrastructure. Positive changes were also associated with improved diagnosis of intrauterine complications and a more active management strategy for preterm birth.

The limitations of the study included variability in data quality in remote areas, a lack of long-term respiratory support, monitoring, and the absence of multidisciplinary teams. In addition, long-term outcomes, including neurological and cognitive disorders, were not assessed, which required further research.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available on request from the corresponding author.

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CONFLICTS OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

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