UDC: 314.18:614.2
DOI: 10.64854/2790-1289-2026-51-1-02
MRNTI: 14.15.15

DEMOGRAPHIC DYNAMICS AND FORECAST: TRENDS IN NATURAL POPULATION INCREASE IN KAZAKHSTAN AND THE DEMOGRAPHIC RESILIENCE OF ALMATY TILL 2030

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Abstract

Relevance. Declining fertility and population aging remain key demographic challenges affecting the sustainability of healthcare systems and long-term socio-economic development.

Objective. To analyze demographic dynamics in the Republic of Kazakhstan and the city of Almaty for 2000-2024 and to forecast births, deaths, and natural population increase for 2025-2030 using time-series analysis methods.

Materials and Methods. Official statistical data from the Bureau of National Statistics of the Republic of Kazakhstan on births, deaths, and natural population increase were analyzed. Absolute and relative growth rates, as well as growth coefficients, were calculated, and time-series dynamics were assessed. Forecasting was performed using the Brown double-exponential smoothing model for births and ARIMA models for deaths, with a projection horizon of 2025-2030. Model quality was evaluated using the coefficient of determination (R^2) and residual diagnostics (Ljung-Box test).

Results. In Kazakhstan, from 2020 to 2024, the number of births declined by 14.25 % (from 426,726 to 365,923), the number of deaths decreased by 17.42 % (from 160,962 to 132,916), resulting in a 12.33 % reduction in natural population increase (from 265,764 to 233,007). In Almaty, the number of births decreased by 3.34 % and the number of deaths by 15.55 %, while the natural population increase rose by 4.98 % to 22,196, reflecting a relatively more stable demographic situation.

Forecast estimates indicate a further decline in the number of births in Kazakhstan – from 347.1 thousand in 2025 to 249.5 thousand by 2030 – with relatively stable mortality, leading to a reduction in natural increase to 105.0 thousand. In Almaty, moderate growth in births (from 35.2 to 39.2 thousand) alongside stable deaths is expected to increase the natural population growth to 26.9 thousand.

Conclusions. Divergent demographic trajectories were identified: increasing demographic pressure at the national level and relative stability in the metropolis. Forecast estimates should be interpreted cautiously, given the inertial nature of time-series models and the lack of external demographic and socio-economic determinants in the projections.

Keywords: *demography, births, mortality, natural population growth, Kazakhstan, forecast.*

Introduction

Demographic changes of the 21st century have a significant impact on healthcare systems, forming new requirements for medical personnel. A decrease in the birth rate and an increase in life expectancy result in population aging. This changes the structure of morbidity and increases the burden on medical infrastructure [1; 2]. Forecasts show that by 2030, the global medical labor market will face a shortage of specialists, especially in countries where demographic changes are occurring most rapidly [3]. The World Health Organization emphasizes the importance of an integrated approach to personnel planning: long-term forecasting, the redistribution of specialists, and the development of necessary competencies must be aligned with new demographic and epidemiological conditions [4].

The experience of countries with successful HR planning models shows that the effectiveness of such systems depends on accounting for future demographic changes. It is important to analyze the growing proportion of the elderly, the decline in the proportion of children, changes in disease structure, and the growing need for geriatric, rehabilitation, and palliative care [1, 2]. Without these data, personnel policy may not meet society's real needs.

In recent years, Kazakhstan has experienced trends similar to those worldwide. According to the Bureau of National Statistics, 388.4 thousand births were registered in 2023, which is lower than the level of 2022 (403.8 thousand). The total fertility rate decreased from 20.57 % in 2022 to 18.29 % in 2024, the lowest rate since 2004 [5; 6]. At the same time, the elderly population is growing, increasing the burden on primary health care, hospitals, and social services.

Despite a decline in the birth rate, the need for medical care has not decreased. It is changing in structure and becoming more associated with chronic diseases and age-related conditions. Socio-demographic factors directly affect the quality of medical services, so the healthcare system needs to adapt organizational processes and personnel decisions [7]. In addition, demographics affect economic growth, budget priorities, and employment, which requires alignment of health policy with the country's economic strategy [8].

Demographic models that account for the population's response to socio-economic conditions are important for more accurate assessments of changes in fertility and age structure [9]. The sustainable development of territories depends on the socio-demographic situation, migration, and local labor markets [10]. Medical and social factors influence reproductive behavior, so they should be taken into account in family support programs and maternity and childhood policies [11]. Regional differences are often explained by socio-economic and environmental conditions [12], as well as the availability of medical services for mothers and children, especially in rural areas and arid regions [13].

Demographic forecasting is an important tool for risk management. Modern approaches use both deterministic and probabilistic methods to account for uncertainty in fertility, mortality, and migration [14; 15]. Long-term forecasts help make early decisions on personnel training, infrastructure development, and financing planning, thereby strengthening the sustainability of health and social support systems [16-23].

Thus, comprehensive and targeted measures are needed: support for families and reproductive health, expansion of geriatric, rehabilitation, and palliative care, training of specialists to account for the aging of the population, and inclusion of demographic forecasting in strategic documents. Such steps will help reduce the risks associated with aging and declining fertility, and maintain the availability and quality of medical care.

Objective. To analyze demographic dynamics in the Republic of Kazakhstan and the city of Almaty for 2000-2024 and to forecast births, deaths, and natural population increase for 2025-2030 using time-series analysis methods.

Materials and methods

Study design and object of analysis

A retrospective analytical study was conducted to assess the dynamics and forecast key demographic indicators. The study subjects were the births, deaths, and natural population increase at the Republic of Kazakhstan and the city of Almaty levels.

Data sources and observation period

The study was based on official statistical data obtained from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (section: «Social Statistics / Demographic Statistics»). The analysis included annual aggregated indicators for the period 2000-2024, ensuring sufficient time-series length to assess long-term trends and construct forecasts.

The following indicators were analyzed:

Number of births (absolute values)

Number of deaths (absolute values)

Natural population increase (absolute values)

Data preparation

At the data preparation stage, completeness and logical consistency of the indicators were verified. Cross-year data comparability was assessed, and the correctness of relationships between core demographic components (births and deaths) was controlled. All indicators were analyzed as annual time series without additional aggregation.

Analysis of demographic dynamics

To evaluate temporal changes, dynamic series were constructed for each indicator separately for the Republic of Kazakhstan and the city of Almaty. The analysis included calculation of absolute changes, growth rates, increase rates, and growth coefficients, which allowed characterization of the direction, intensity, and stability of demographic changes over the long observation period.

Dynamic analysis served as a preliminary stage necessary to identify time-series structure and justify the selection of forecasting methods.

Forecasting methods

Forecasting of demographic indicators was performed using time-series data for 2000-2024, with a projection horizon for 2025-2030. The choice of forecasting techniques was determined by the structural properties of the series, including the presence or absence of stable trends and seasonal fluctuations.

Fertility forecasting

Fertility forecasting was conducted using the Brown double-exponential smoothing method, designed for time series with a pronounced trend but no seasonality. The method accounts for both the current level of the indicator and the direction of its change over time, making it suitable for medium-term demographic forecasting.

Separate models were constructed for the Republic of Kazakhstan and the city of Almaty. For the Republic of Kazakhstan, annual data for 2000-2024 were used. For the city of Almaty, the births forecast was based on the pre-COVID period (2000-2019), as the years 2020–2021 represented a structural disturbance in the time series.

Mortality forecasting

Mortality forecasting was performed using ARIMA-class models, which account for autocorrelation and the stochastic nature of indicator changes. Model parameters were identified based on time-series structure using standard identification and estimation procedures. ARIMA models were developed separately for the Republic of Kazakhstan and the city of Almaty. For the city of Almaty, the final mortality model was specified as ARIMA (1,0,0).

Estimation of natural population increase

Natural population increase was treated as a derived demographic indicator and, in the forecasting stage, was calculated as the difference between projected births and deaths. Separate modeling of natural increase was not performed, ensuring methodological consistency of forecast estimates.

Model quality assessment and interpretation

Constructed forecasting models were evaluated using standard statistical goodness-of-fit measures and residual diagnostics commonly applied in time-series analysis.

For birth forecasting models based on Brown double exponential smoothing, the primary measure of explanatory power was the coefficient of determination (R^2), reflecting the proportion of variance in the original time series explained by the model. High R^2 values were interpreted as evidence of adequate representation of the trend component and consistency with observed dynamics.

Residual diagnostics were additionally performed. Autocorrelation testing used the Ljung-Box Q statistic. The absence of statistically significant residual autocorrelation ($p > 0.05$) was considered evidence of correct model specification and random forecast errors, indicating statistical stability and suitability for medium-term forecasting.

For mortality forecasting, ARIMA-class models were applied, which are appropriate for time series with stochastic structures and potential autocorrelation. Model evaluation included analysis of the coefficient of determination (R^2) as a generalized goodness-of-fit measure and mandatory residual autocorrelation testing using the Ljung-Box criterion. p-values > 0.05 were interpreted as confirmation that the model adequately described the time-series structure without leaving systematic dependencies in residuals.

A comparative evaluation of alternative models (including automatic ARIMA models for fertility series) was conducted using combined criteria: goodness-of-fit, interpretability, and residual behavior. When more complex models failed to improve fit or yielded statistically inadequate residuals, preference was given to simpler, more robust specifications.

Thus, the selection of Brown models

for forecasting births and ARIMA models for forecasting deaths was determined not only by time-series structure but also by statistical diagnostics confirming the validity and reliability of the obtained forecast estimates.

Software

Statistical processing and data analysis were performed using IBM SPSS Statistics version 26.0 and Microsoft Excel. SPSS was used for time-series analysis and forecasting, while Excel was used to prepare source data, calculate dynamic indicators, and develop tables and graphical outputs.

Results

According to the data presented in Table 1, in the city of Almaty, 2020-2024, the demographic dynamics were characterized by relative stability of key indicators. Over the analyzed period, the number of births decreased slightly, by 1,187 cases (-3.34 %), while the number of deaths declined more noticeably, by 2,240 cases (-15.55 %). As a result, the natural population increase in the metropolis not only persisted but also showed positive dynamics, rising from 21,143 to 22,196 persons, corresponding to an absolute increase of 1,053 (+4.98 %) and a growth coefficient of 1.05.

Such a ratio of indicators points to the demographic sustainability of the country's largest city and the preservation of the population's reproductive potential in a metropolitan environment.

In the Republic of Kazakhstan as a whole, a more pronounced downward trend was observed during the same period. The number of births decreased from 426,726 to 365,923 persons (–60,803; –14.25 %), and mortality declined from 160,962 to 132,916 cases (–28,046; –17.42 %). Against this background, the natural population increase decreased by 32,757 persons (–12.33 %), falling from 265,764 to 233,007, with a growth coefficient of 0.88.

Table 1. Dynamics of Demographic Indicators of the Population of the Republic of Kazakhstan, 2000-2024

Year	Republic of Kazakhstan			City of Almaty		
	Births	Deaths	Natural Increase	Births	Deaths	Natural Increase
2000	222,054	149,778	72,276	14,900	12,183	2,717
2001	221,487	147,876	73,611	13,782	11,915	1,867
2002	227,171	149,381	77,790	16,093	11,898	4,195
2003	247,946	155,277	92,669	19,607	12,839	6,768
2004	273,028	152,250	120,778	23,647	13,056	10,591
2005	278,977	157,121	121,856	25,737	13,535	12,202
2006	301,756	157,210	144,546	28,119	12,199	15,920
2007	321,963	158,297	163,666	29,625	12,048	17,577
2008	357,555	152,878	204,677	34,041	12,226	21,815
2009	356,326	143,031	213,295	26,758	11,650	15,108
2010	367,785	146,220	221,565	26,892	12,314	14,578
2011	372,796	144,503	228,293	26,505	11,956	14,549
2012	381,272	143,690	237,582	28,257	11,767	16,490
2013	387,372	136,672	250,700	28,765	11,333	17,432
2014	399,448	132,619	266,829	29,691	11,076	18,615
2015	398,591	131,292	267,299	31,167	10,614	20,553
2016	401,031	131,983	269,048	31,733	10,869	20,864
2017	390,505	129,173	261,332	31,481	11,004	20,477
2018	397,618	129,680	267,938	33,240	11,643	21,597
2019	401,869	132,621	269,248	34,281	12,168	22,113
2020	426,726	160,962	265,764	35,546	14,403	21,143
2021	445,875	181,216	264,659	37,794	18,104	19,690
2022	403,893	133,523	270,370	36,110	12,221	23,889
2023	388,428	130,686	257,742	35,488	11,923	23,565
2024	365,923	132,916	233,007	34,359	12,163	22,196

**Note: All indicators are presented as absolute values (number of persons).*

Source: compiled by the authors

According to Table 2, the projected dynamics of births in Almaty were assessed using the Brown double-exponential smoothing model. Because the pandemic years introduced a structural disturbance into the series, the Almaty births model was estimated on the pre-COVID period (2000-2019), which provided a more stable baseline trajectory for medium-term forecasting. The selection of this model was justified by the presence of a stable trend, with no pronounced seasonality. The goodness-of-fit was satisfactory ($R^2 = 0.855$), and diagnostic statistics confirmed the adequacy of the model: no residual autocorrelation was detected (Q (18) = 9.825; p = 0.937), and the BIC value of 15.653 indicated an acceptable level of model complexity.

In 2025-2030, the metropolis is expected to experience a moderate increase in births, from 35.2 thousand to 39.2 thousand per year. At the same time, confidence intervals gradually widen, reflecting increasing uncertainty as the forecasting horizon extends.

The number of deaths in Almaty was modeled using ARIMA (1,0,0) for the period 2000-2024. Residual diagnostics showed no statistically significant autocorrelation (Ljung–Box Q (18)

Table 2. Projected Key Demographic Indicators for the Republic of Kazakhstan and the City of Almaty till 2030

Republic of Kazakhstan			
Year	**Birth Forecasts (Brown model)**	**Death Forecasts**	**Natural Increase Forecast**
2025	347,094 (313,202-380,987)	134,771 (112,418-157,124)	212,323
2026	327,574 (269,421-385,728)	144,512 (117,473-171,550)	183,062
2027	308,054 (221,781-394,327)	144,512 (117,473-171,550)	163,542
2028	288,533 (170,741-406,326)	144,512 (117,473-171,550)	144,021
2029	269,013 (116,631-421,395)	144,512 (117,473-171,550)	124,501
2030	249,493 (59,699-439,287)	144,512 (117,473-171,550)	104,981
Model characteristics:	Model: Brown; period: 2000–2024; forecast: 2025–2030; $R^2 = 0.941$; Q (18) = 10.372; p = 0.887; BIC = 19.541.	Model: ARIMA (0,0,1) (2000–2024), forecast 2025–2030; $R^2 = 0.328$; Q (18) = 4.295; p = 0.999; BIC = 18.838.	The difference between the number of births and deaths
City of Almaty			
2025	35,170 (30,317-40,023)	12,231 (9,437-15,024)	22,939
2026	35,981 (29,117-42,844)	12,259 (9,237-15,280)	23,722
2027	36,791 (28,386-45,197)	12,270 (9,212-15,329)	24,521
2028	37,602 (27,896-47,308)	12,275 (9,210-15,340)	25,327
2029	38,413 (27,561-49,265)	12,277 (9,211-15,343)	26,136
2030	39,224 (27,336-51,111)	12,278 (9,212-15,344)	26,946
Model characteristics:	Model: Brown (double exponential smoothing); estimation period: 2000–2019; forecast: 2025–2030; $R^2 = 0.855$; Q (18) = 9.825; p = 0.937; BIC = 15.653.	Model: ARIMA (1,0,0) (2000–2024), forecast 2025–2030; Ljung–Box Q (18) = 5.55; p = 0.996.	The difference between the number of births and deaths

**Note: All indicators are presented as absolute values (number of persons).*
Source: compiled by the authors

= 5.55; p = 0.996), indicating adequate model specification. The projected values suggest near-stable mortality with gradual convergence toward the long-term mean.

Taken together, the forecast estimates show that Almaty is expected to maintain a positive trend in natural population increase in the medium term: due to moderate growth in births combined with stable deaths, the indicator will rise from 22.9 thousand to 26.9 thousand persons by 2030. This reflects the demographic sustainability of the metropolis and the preservation of the population's reproductive potential.

In contrast, projected trends for the Republic of Kazakhstan, as shown in Table 2, demonstrate a different pattern. The Brown exponential smoothing model (R^2 = 0.941) indicates a steady decline in births, from 347.1 thousand in 2025 to 249.5 thousand in 2030. According to the ARIMA (0,0,1) model, the number of deaths is expected to remain relatively stable. As a result, a substantial reduction in natural increase is projected, from 212.3 thousand to 105.0 thousand persons, reflecting increasing demographic pressure nationwide.

Figure 1 presents observed and forecast values of births and deaths for the Republic of Kazakhstan and the city of Almaty. The upper panels display fertility trends, while the lower panels reflect mortality dynamics. The left-hand panels correspond to Almaty, and the right-hand panels represent national-level indicators for the Republic of Kazakhstan.

As illustrated in the figure, in the Republic of Kazakhstan, the forecast period is characterized by a persistent downward trend in births, whereas deaths show relative stabilization without a pronounced directional trend. As a result, a substantial decline in the natural population increase is observed, although it remains positive within the projected time horizon.

In contrast, the demographic trajectory of the city of Almaty differs: the forecast indicates moderate growth in births alongside nearly stable deaths, ensuring the preservation and even expansion of natural population growth. Thus, the figure clearly demonstrates the divergence of demographic trends between the national level and the country's largest metropolitan area.

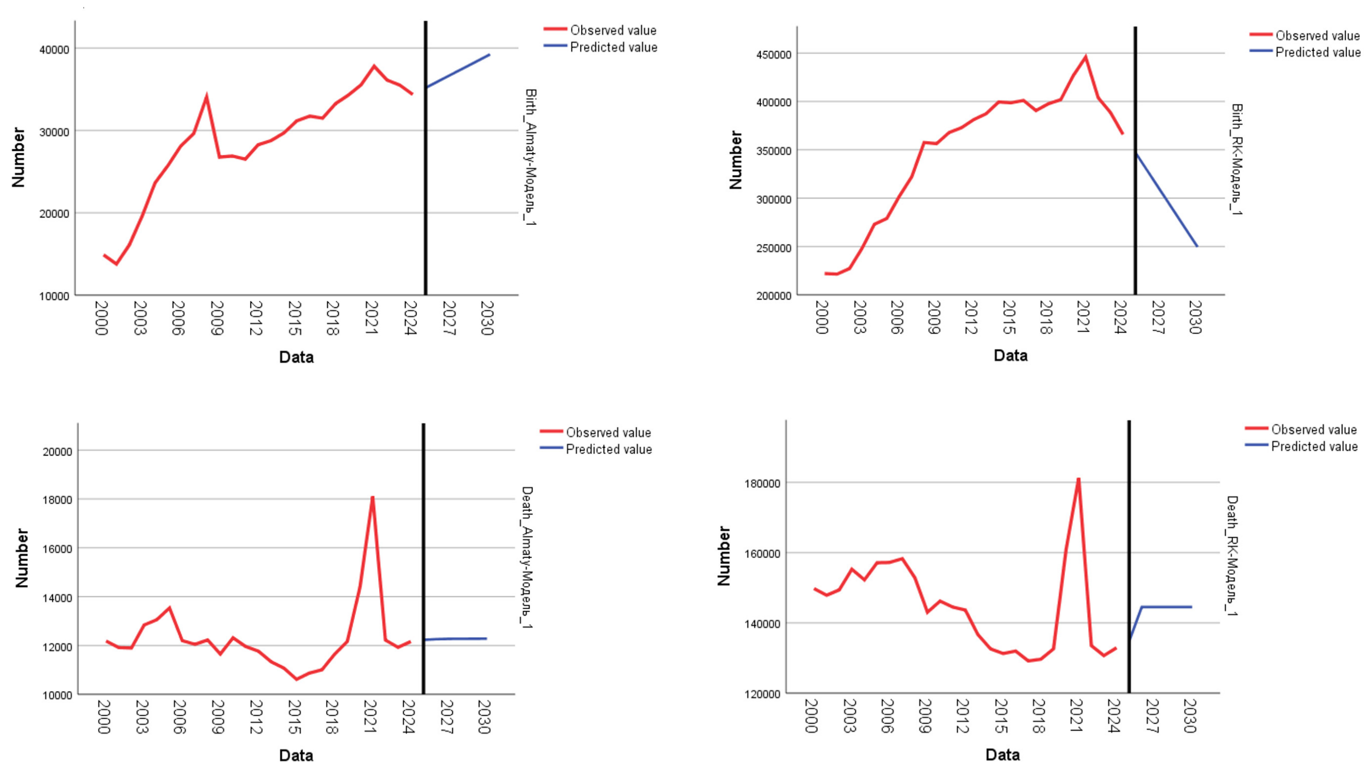

Figure 1. Observed and Forecasted Births, Deaths, and Natural Population Increase in the Republic of Kazakhstan and the City of Almaty, 2000-2030

**Note: All indicators are presented as absolute values (number of persons)*

Source: compiled by the authors

Discussion

The analysis of demographic indicators for the Republic of Kazakhstan and the city of Almaty for 2020-2024 revealed trends comparable to global demographic processes, including declining births and a transformation of the population structure [1; 2]. Over the study period, the number of births in Kazakhstan decreased from 426,726 to 365,923 (–14.25 %), while the natural population increase declined by 12.33 %, from 265,764 to 233,007. Despite a 17.42 % reduction in deaths, the steeper decline in births led to an overall decrease in natural population growth.

In Almaty, demographic dynamics were less adverse. The number of births declined by 3.34 %, mortality decreased by 15.55 %, while the natural population conversely increased to 22,196 (+4.98 %), reflecting a more stable demographic situation in the metropolis compared with national trends [9; 10].

To assess prospective demographic dynamics, time-series methods were applied, including the Brown double exponential smoothing model for birth forecasting and ARIMA models for death forecasting. The selection of these approaches was justified by the presence of a pronounced trend component in the absence of stable seasonality. The application of these models not only smoothed short-term fluctuations but also enabled the statistically grounded medium-term forecasts of demographic indicators.

Modeling results demonstrated divergent demographic trajectories. In the Republic of Kazakhstan, the number of births is projected to decline steadily – from 347.1 thousand in 2025 to 249.5 thousand by 2030 – with mortality remaining relatively stable. This will lead to a substantial reduction in natural population increase, from 212.3 thousand to 105.0 thousand, indicating intensifying demographic pressure and acceleration of population aging processes, consistent with international evidence on demographic transition risks [1; 2].

In contrast, the projected dynamics for Almaty differ: moderate growth in births is expected alongside nearly stable deaths, ensuring a positive natural population increase, rising to 26.9 thousand by 2030. This reflects relatively more stable demographic trends in the country's largest metropolis. The identified demographic patterns may have important implications for healthcare planning, particularly amid population aging and changing demand for medical services. However, the present study does not directly evaluate healthcare demand or workforce requirements; therefore, these implications should be interpreted only as potential policy considerations.

An increasing proportion of older age groups is associated with growing demand for long-term care, rehabilitation, palliative services, as well as cardiology and neurology care [7]. This necessitates revising workforce policies, including redistributing specialists, developing geriatric competencies, and adapting healthcare infrastructure.

Demographic processes are closely linked to socio-economic factors, influencing economic growth, budget planning, and labor market structure, underscoring the need to align healthcare strategies with macroeconomic development scenarios [8]. Fertility dynamics are shaped by marital and reproductive behavior, migration flows, and population responses to socio-economic transformations [9].

The territorial dimension is also critical: differences in urbanization, employment, migration attractiveness, and access to healthcare services generate demographic disparities between metropolitan and peripheral regions [10]. Fertility levels are influenced by the availability of maternal and child health services, quality of care, and family social support measures [11]. Regional disparities are further reinforced by socio-economic and environmental conditions [12], as well as unequal distribution of healthcare infrastructure, particularly in rural and sparsely populated areas [13].

From a risk-management perspective, demographic forecasting remains an essential analytical tool. The use of multiple scenarios of fertility, mortality, and migration, along with consideration of the probabilistic nature of demographic change, is necessary for informed decision-making [14; 15]. Extending forecasting horizons enables planning of workforce training, infrastructure development, and social support measures, thereby mitigating the potential consequences of transition toward natural population decline [16; 22].

Strengths of the study

A key strength of this study is the use of a long retrospective observation period (2000-

2024), which enabled the identification of stable demographic trends and improved the reliability of forecast estimates. The application of time-series methods allowed the identification of long-term trends and the construction of medium-term forecast estimates, while residual diagnostics supported the adequacy of the selected models.

Another important strength is the comparative analysis conducted at two levels – national and metropolitan – which enabled the identification of divergent demographic trajectories and the justification for differentiated strategic planning.

Limitations of the study

This study has several limitations that should be considered when interpreting the findings.

First, despite the long time series, the applied models primarily rely on extrapolating historical trends and do not account for external factors that can significantly alter demographic dynamics. These include pandemics, large-scale migration flows, economic crises, and shifts in family or social policy.

Second, the forecasting models did not incorporate migration indicators, marital and reproductive behavior, age-specific fertility rates, or other socio-demographic determinants, which limits the explanatory and predictive capacity of the estimates, particularly for large urban settings such as Almaty.

Third, although the selected models demonstrated acceptable statistical adequacy, forecast estimates represent probabilistic scenarios rather than deterministic outcomes and therefore require cautious interpretation in strategic planning contexts.

Fourth, for the city of Almaty, the births forecast was based on the pre-COVID period, because the years 2020-2021 introduced a structural disturbance into the series. Therefore, the projected trajectory should be interpreted as a continuation of the pre-pandemic trend rather than as a direct extrapolation of the full 2000–2024 period.

Conclusion

Overall, the findings indicate increasing demographic pressure in the Republic of Kazakhstan, amid a projected decline in births and a relatively stable number of deaths. In contrast, the city of Almaty demonstrates relative demographic stability in the medium term. These differences underscore the need for territorially differentiated demographic, social, and healthcare workforce policies.

References

1. Cervero R. M., Daley B. J. The need and curricula for health professions education graduate programs // New Directions for Adult and Continuing Education. – 2018. – No. 157. – P. 7-16. – DOI: https://doi.org/10.1002/ace.20264

2. Lee J. T., et al. Methods for health workforce projection model: systematic review and recommended good practice reporting guideline // Human Resources for Health. – 2024. – Vol. 22, No. 1. – Article No. 25. – DOI: https://doi.org/10.1186/s12960-024-00895-z

3. Liu J. X., Goryakin Y., Maeda A., Bruckner T., Scheffler R. Global health workforce labor market projections for 2030 // Human Resources for Health. – 2017. – Vol. 15(1). – Article No. 11. – DOI: https://doi.org/10.1186/s12960-017-0193-4

4. World Health Organization. Global strategy on human resources for health: workforce 2030. – Geneva: WHO, 2016. – URL: https://www.who.int/publications/i/item/9789241511131 (accessed: 20.09.2025).

5. Bureau of National Statistics of the Republic of Kazakhstan. On the birth rate in 2023. – 2023. – Available at: https://stat.gov.kz (accessed: 20.09.2025).

6. Zhankubayev B. A., et al. Socio-demographic situation in Kazakhstan: Problems of reproduction // Revista de Cercetare si Interventie Sociala. – 2021. – No. 75. – P. 139-154. – DOI: https://doi.org/10.33788/rcis.75.9

7. Buja A., et al. Are hospital process quality indicators influenced by socio-demographic health determinants // European Journal of Public Health. – 2015. – Vol. 25(5). – P. 759-765. – DOI: https://doi.org/10.1093/eurpub/cku253

8. Pasichnyi M., Nepytaliuk A. The contributions of demographic factors to economic growth // Problemy Ekorozwoju. – 2021. – Vol. 16(1). – P. 219-229. – DOI: https://doi.org/10.35784/pe.2021.1.24

9. Kozlova O. A., Makarova M. N., Sekitski-Pavlenko O. O. Models for the dynamics of demographic indicators under socio-economic adaptation // Economic and Social Changes: Facts, Trends, Forecast. – 2021. – Vol. 14(4). – P. 48-58. – DOI: https://doi.

org/10.15838/esc.2021.4.76.3
10. Humeniuk V., Kaziuka N., Sheketa Y. Socio-demographic factors influencing sustainable development of Carpathian Euroregion // Grassroots Journal of Natural Resources. – 2021. – Vol. 4(1). – P. 106-122. – DOI: https://doi.org/10.33002/nr2581.6853.040108
11. Irina S. L., et al. Demographic indicators of fertility and medico-social influences on them // Journal of Obstetrics and Women's Diseases. – 2017. – Vol. 66(2). – P. 40-48. – DOI: https://doi.org/10.17816/JOWD66240-48
12. Burkin M. M., Molchanova E. V., Kruchek M. M. Integral criterion of influence of social, economic and environmental factors on regional demographic processes // Ekologiya cheloveka. – 2016. – Vol. 23(6). – P. 39-46. – DOI: https://doi.org/10.33396/1728-0869-2016-6-39-46
13. Nzioki J. M., Onyango R. O., Ombaka J. H. Socio-demographic factors influencing maternal and child health service utilization in Mwingi // American Journal of Public Health Research. – 2015. – Vol. 3(1). – P. 21-30. – DOI: https://doi.org/10.12691/ajphr-3-1-4
14. Mazzuco S., Keilman N. Developments in demographic forecasting. – Cham: Springer Nature, 2020. – DOI: https://doi.org/10.1007/978-3-030-42472-5
15. Keilman N. Probabilistic demographic forecasts // Vienna Yearbook of Population Research. – 2018. – Vol. 16. – P. 25-36. – DOI: https://doi.org/10.1553/populationyearbook2018s025
16. Макаров В. Л., Бахтизин А. Р. Долгосрочное демографическое прогнозирование в новых реалиях // Научные труды Вольного экономического общества России. – 2022. – No. 3. – URL: https://cyberleninka.ru/article/n/dolgosrochnoe-demograficheskoe-prognozirovanie-v-novyh-realiyah (accessed: 20.09.2025).
17. Rafiei S., et al. Approaches in health human resource forecasting: a roadmap for improvement // Electronic Physician. – 2016. – Vol. 8(9). – P. 2911-2920. – DOI: https://doi.org/10.19082/2911
18. Bosak S., Yazdani S., Ayati M. H. Approaches and components of health workforce planning models // Iranian Journal of Medical Sciences. – 2023. – Vol. 48(4). – P. 358-366. – DOI: https://doi.org/10.30476/ijms.2022.94662.2600
19. Kroezen M., Van Hoegaerden M., Batenburg R. Joint Action on Health Workforce Planning and Forecasting // Health Policy. – 2018. – Vol. 122(2). – P. 87-93. – DOI: https://doi.org/10.1016/j.healthpol.2017.12.002
20. Stanimirovic D., Pribakovic Brinovec R. Human resource planning in health care // pHealth 2022. – 2022. – P. 279–282. – DOI: https://doi.org/10.3233/SHTI220999
21. Cruz-Gomes S., Amorim-Lopes M., Almada-Lobo B. A labor requirements function for sizing the health workforce // Human Resources for Health. – 2018. – Vol. 16(1). – Article No. 67. – DOI: https://doi.org/10.1186/s12960-018-0334-4
22. Asamani J. A., Christmals C. D., Reitsma G. M. Advancing needs-based workforce planning methodology // International Journal of Environmental Research and Public Health. – 2021. – Vol. 18(4). – Article No. 2113. – DOI: https://doi.org/10.3390/ijerph18042113
23. Sutton C., et al. Strategic workforce planning in health and social care // Health Policy. – 2023. – Vol. 132. – Article No. 104827. – DOI: https://doi.org/10.1016/j.healthpol.2023.104827

References

1. Cervero, R. M., & Daley, B. J. (2018). The need and curricula for health professions education graduate programs. New Directions for Adult and Continuing Education, 2018(157), 7-16. DOI: https://doi.org/10.1002/ace.20264.
2. Lee, J. T., et al. (2024). Methods for health workforce projection model: Systematic review and recommended good practice reporting guideline. Human Resources for Health, 22(1), Article 25. DOI: https://doi.org/10.1186/s12960-024-00895-z.
3. Liu, J. X., Goryakin, Y., Maeda, A., Bruckner, T., & Scheffler, R. (2017). Global health workforce labor market projections for 2030. Human Resources for Health, 15(1), Article 11. DOI: https://doi.org/10.1186/s12960-017-0193-4
4. World Health Organization. (2016). Global strategy on human resources for health: Workforce 2030. WHO. Retrieved September 20, 2025, from https://www.who.int/publications/i/item/9789241511131
5. Byuro natsional'noy statistiki Respubliki Kazakhstan. (2023). On birth rates in 2023. Retrieved September 20, 2025, from https://stat.gov.kz
6. Zhankubayev, B. A., et al. (2021). Socio-demographic situation in Kazakhstan: Problems of reproduction. Revista de Cercetare si Interventie So-

ciala, (75), 139-154. DOI: https://doi.org/10.33788/rcis.75.9
7. Buja, A., et al. (2015). Are hospital process quality indicators influenced by socio-demographic health determinants? European Journal of Public Health, 25(5), 759-765. DOI: https://doi.org/10.1093/eurpub/cku253
8. Pasichnyi, M., & Nepytaliuk, A. (2021). The contributions of demographic factors to economic growth. Problemy Ekorozwoju, 16(1), 219-229. DOI: https://doi.org/10.35784/pe.2021.1.24
9. Kozlova, O. A., Makarova, M. N., & Sekitski-Pavlenko, O. O. (2021). Models for the dynamics of demographic indicators under socio-economic adaptation. Economic and Social Changes: Facts, Trends, Forecast, 14(4), 48-58. DOI: https://doi.org/10.15838/esc.2021.4.76.3
10. Humeniuk, V., Kaziuka, N., & Sheketa, Y. (2021). Socio-demographic factors influencing sustainable development of Carpathian Euroregion. Grassroots Journal of Natural Resources, 4(1), 106-122. DOI: https://doi.org/10.33002/nr2581.6853.040108
11. Irina, S. L., et al. (2017). Demographic indicators of fertility and medico-social influences on them. Journal of Obstetrics and Women's Diseases, 66(2), 40-48. DOI: https://doi.org/10.17816/JOWD66240-48
12. Burkin, M. M., Molchanova, E. V., & Kruchek, M. M. (2016). Integral criterion of influence of social, economic and environmental factors on regional demographic processes. Ekologiya Cheloveka (Human Ecology), 23(6), 39-46. DOI: https://doi.org/10.33396/1728-0869-2016-6-39-46
13. Nzioki, J. M., Onyango, R. O., & Ombaka, J. H. (2015). Socio-demographic factors influencing maternal and child health service utilization in Mwingi. American Journal of Public Health Research, 3(1), 21-30. DOI: https://doi.org/10.12691/ajphr-3-1-4
14. Mazzuco, S., & Keilman, N. (2020). Developments in demographic forecasting. Springer Nature. DOI: https://doi.org/10.1007/978-3-030-42472-5
15. Keilman, N. (2018). Probabilistic demographic forecasts. Vienna Yearbook of Population Research, 16, 25-36. DOI: https://doi.org/10.1553/populationyearbook2018s025
16. Makarov, V. L., & Bakhtizin, A. R. (2022). Dolgosrochnoe demograficheskoe prognozirovanie v novykh realiyakh. Nauchnye Trudy Vol′nogo Ekonomicheskogo Obshchestva Rossii, (3). Retrieved September 20, 2025, from https://cyberleninka.ru/article/n/dolgosrochnoe-demograficheskoe-prognozirovanie-v-novyh-realiyah
17. Rafiei, S., et al. (2016). Approaches in health human resource forecasting: A roadmap for improvement. Electronic Physician, 8(9), 2911-2920. DOI: https://doi.org/10.19082/2911
18. Bosak, S., Yazdani, S., & Ayati, M. H. (2023). Approaches and components of health workforce planning models. Iranian Journal of Medical Sciences, 48(4), 358-366. DOI: https://doi.org/10.30476/ijms.2022.94662.2600
19. Kroezen, M., Van Hoegaerden, M., & Batenburg, R. (2018). Joint action on health workforce planning and forecasting. Health Policy, 122(2), 87-93. DOI: https://doi.org/10.1016/j.healthpol.2017.12.002
20. Stanimirovic, D., & Pribakovic Brinovec, R. (2022). Human resource planning in health care. In pHealth 2022, 279-282. DOI: https://doi.org/10.3233/SHTI220999
21. Cruz-Gomes, S., Amorim-Lopes, M., & Almada-Lobo, B. (2018). A labor requirements function for sizing the health workforce. Human Resources for Health, 16(1), 67. DOI: https://doi.org/10.1186/s12960-018-0334-4.
22. Asamani, J. A., Christmals, C. D., & Reitsma, G. M. (2021). Advancing needs-based workforce planning methodology. International Journal of Environmental Research and Public Health, 18(4), 2113. DOI: https://doi.org/10.3390/ijerph18042113.
23. Sutton, C., et al. (2023). Strategic workforce planning in health and social care. Health Policy, 132,104827. DOI: https://doi.org/10.1016/j.healthpol.2023.104827

ДЕМОГРАФИЯЛЫҚ ДИНАМИКА ЖӘНЕ БОЛЖАМ: ҚАЗАҚСТАНДАҒЫ ХАЛЫҚТЫҢ ТАБИҒИ ӨСІМІНІҢ ҮРДІСТЕРІ ЖӘНЕ АЛМАТЫНЫҢ 2030 ЖЫЛҒА ДЕЙІНГІ ДЕМОГРАФИЯЛЫҚ ТҰРАҚТЫЛЫҒЫ

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Аңдатпа

Өзектілігі. Туу деңгейінің төмендеуі және халықтың қартаюы денсаулық сақтау жүйесінің тұрақтылығына және ұзақ мерзімді әлеуметтік-экономикалық дамуға әсер ететін негізгі демографиялық сын-қатерлердің бірі болып табылады.

Мақсаты. 2000-2024 жылдар аралығында Қазақстан Республикасы мен Алматы қаласындағы демографиялық көрсеткіштердің динамикасын талдау және анықталған үрдістер негізінде табиғи өсімді уақыттық қатарлар әдістерін қолдана отырып болжау.

Материалдар мен әдістер. Қазақстан Республикасы Стратегиялық жоспарлау және реформалар агенттігі Ұлттық статистика бюросының ресми деректері пайдаланылды. Туу, өлім-жітім және табиғи өсім көрсеткіштері бойынша абсолюттік және салыстырмалы өсім қарқындары, өсу коэффициенттері есептеліп, динамикалық қатарлар талданды. Болжам жасау үшін туу көрсеткішіне Браунның қос экспоненциалды тегістеу моделі, ал өлім-жітімге ARIMA модельдері қолданылды. Болжам көкжиегі – 2025–2030 жж. Модель сапасы детерминация коэффициенті (R^2) және қалдықтарды диагностикалау (Льюнг–Бокс критерийі) арқылы бағаланды.

Нәтижелері. 2020–2024 жж. Қазақстанда туу 14,25 %-ға (426 726-дан 365 923-ке), өлім-жітім 17,42 %-ға (160 962-ден 132 916-ға) төмендеді, бұл табиғи өсімнің 12,33 %-ға (265 764-тен 233 007-ге) қысқаруымен қатар жүрді. Алматы қаласында туу 3,34 %-ға, өлім-жітім 15,55 %-ға төмендегенімен, табиғи өсім 4,98 %-ға өсіп, 22 196 адамды құрады.

Болжам бойынша, Қазақстанда туу деңгейі 2025 жылғы 347,1 мыңнан 2030 жылға қарай 249,5 мыңға дейін төмендейді, өлім-жітім салыстырмалы тұрақты қалып, табиғи өсім 105,0 мың адамға дейін қысқарады. Алматыда, керісінше, туу көрсеткішінің қалыпты өсуі (35,2 мыңнан 39,2 мыңға дейін) және өлім-жітімнің тұрақтылығы табиғи өсімнің 26,9 мың адамға дейін ұлғаюын қамтамасыз етеді.

Қорытынды. Демографиялық үрдістердің қарама-қарсы бағытта дамуы анықталды: ұлттық деңгейде демографиялық қысымның күшеюі және мегаполистің салыстырмалы тұрақтылығы. Болжам нәтижелерін уақыттық қатарлар модельдерінің инерциялық сипатын және сыртқы демографиялық-әлеуметтік факторлардың ескерілмеуін назарға ала отырып, сақтықпен түсіндіру қажет.

Түйін сөздер: *демография, туу, өлім, халықтың табиғи өсімі, Қазақстан, болжам.*

ДЕМОГРАФИЧЕСКАЯ ДИНАМИКА И ПРОГНОЗ: ТЕНДЕНЦИИ ЕСТЕСТВЕННОГО ПРИРОСТА НАСЕЛЕНИЯ В КАЗАХСТАНЕ И ДЕМОГРАФИЧЕСКАЯ УСТОЙЧИВОСТЬ АЛМАТЫ ДО 2030 ГОД

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Аннотация

Актуальность. Снижение уровня рождаемости и старение населения остаются ключевыми демографическими вызовами, оказывающими влияние на устойчивость систем здравоохранения и долгосрочное социально-экономическое развитие.

Цель. Проанализировать динамику демографических показателей в Республике Казахстан и городе Алматы за период 2000-2024 гг. и спрогнозировать естественный прирост населения на основе методов временных рядов с учётом выявленных тенденций.

Материалы и методы. Проанализированы официальные статистические данные Бюро национальной статистики Республики Казахстан по рождаемости, смертности и естественному приросту населения. Рассчитаны абсолютные и относительные темпы роста, коэффициенты роста, проведён анализ динамических рядов. Прогнозирование выполнено с использованием модели двойного экспоненциального сглаживания Брауна (для рождаемости) и ARIMA-моделей (для смертности) с горизонтом прогноза 2025–2030 гг. Качество моделей оценивалось по коэффициенту детерминации (R^2) и диагностике остатков (критерий Льюнга-Бокса).

Результаты. В Республике Казахстан в 2020–2024 гг. число рождений снизилось на 14,25 % (с 426 726 до 365 923), смертность – на 17,42 % (с 160 962 до 132 916), что сопровождалось сокращением естественного прироста на 12,33 % (с 265 764 до 233 007). В городе Алматы снижение рождаемости составило 3,34 %, смертности – 15,55 %, при этом естественный прирост увеличился на 4,98 % и достиг 22 196 человек.

Согласно прогнозу, в Казахстане ожидается дальнейшее снижение рождаемости – с 347,1 тыс. в 2025 г. до 249,5 тыс. к 2030 г. при относительно стабильной смертности, что приведёт к сокращению естественного прироста до 105,0 тыс. человек. В Алматы прогнозируется умеренный рост рождаемости (с 35,2 тыс. до 39,2 тыс.) при стабильной смертности, что обеспечит увеличение естественного прироста до 26,9 тыс. человек.

Выводы. Выявлены разнонаправленные демографические тенденции: усиление демографического давления на национальном уровне и относительная устойчивость мегаполиса. Прогнозные оценки следует интерпретировать с осторожностью, учитывая инерционный характер моделей временных рядов и отсутствие учёта внешних демографических и социально-экономических факторов.

Ключевые слова: *демография, рождаемость, смертность, естественный прирост населения, Казахстан, прогноз.*

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Authors' contribution. *Conceptualization: Abzaliyeva A. R., Baimuratova M. A.; Methodology: Abzaliyeva A. R., Baimuratova M. A.; Formal analysis: Abzaliyeva A. R., Laktionova M.V., Dosmailova I. M., Abzaliyev Zh. R., Ozbekbay U. Z.; Data curation: Abzaliyeva A. R., Laktionova M. V., Ozbekbay U. Z.; Writing – original draft preparation: Abzaliyeva A. R., Baimuratova M. A., Ozbekbay U. Z.; Writing – review and editing: Baimuratova M. A.*
Conflict of interest. *The authors declare no conflict of interest.*
Funding. *This research received no external funding.*
Acknowledgments. *The authors would like to thank the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for providing official demographic data.*
All authors have approved the final version of the article and are responsible for its content.

Article received: 13.11.2025year.
Accepted for publication:26.12.2025 year.