Review article

Historical evolution of healthcare systems of post-soviet Russia, Belarus, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Armenia, and Azerbaijan: A scoping review

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A B S T R A C T

This scoping review addresses the transformation and development of new healthcare systems in nine countries —Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, and Uzbekistan over the period following the collapse of the Soviet Union from 1991 to the present. This assessment focuses on maternal and child health, mental health, communicable diseases, and non-communicable diseases in an effort to highlight the changes in the healthcare status of these nine countries under scrutiny. Considering that all the post-Soviet nations are officially recognized members of the World Health Organization (WHO) and have demonstrated their commitment to attaining the WHO's objectives, the evaluation of healthcare system progress and improvement was carried out utilizing indicators provided by the WHO. This review reveals that the evolution of healthcare systems could be considered sustainable, given that average life expectancy has returned to the level it was in 1991— the year of the USSR's breakup, and people's health has improved since the turn of the twenty-first century. To enhance the potential success of future healthcare reforms, however, governments must monitor implementation of the reform process, evaluate the achievement of objectives, and make necessary adjustments. The success of future healthcare changes will depend on the active involvement of the government, medical community, and patient community, as well as obtaining the support of local health authorities. This study may help identify successful and failed strategies, guiding future healthcare changes and investments.

1. Introduction

The dissolution of the Soviet Union (USSR) in 1991 was one of the key events of the second half of the twentieth century. The USSR collapse was a protracted process brought on by political unrest, economic stagnation, and ethnic separatism [1]. Fifteen newly

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independent states (Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan) were faced with both new challenges and new opportunities [2]. Although most of the former Soviet republics maintained close socioeconomic and cultural relations with the Russian Federation (hereafter – Russia), giving a base for a range of multilateral organizations, three Baltic states (Estonia, Latvia, and Lithuania) joined the European Union (EU) and North Atlantic Treaty Organization (NATO), while some other countries (Georgia, Moldova, and Ukraine) declared their willingness to follow the same path [3,4]. In addition, all of the newly independent republics experienced political and economic crises following the dissolution of the USSR. For every newly independent state, the intensity and duration of the crisis depended on the availability of natural resources, development of industry and human capital, and commitment to reforms. According to some estimates, the decrease in living standards was very profound and larger than it was during the Great Depression [4]. Further, all post-Soviet countries witnessed a decline in gross domestic product (GDP) and wages during the early transition phase following the dissolution of the USSR. This decline was most noticeable in Russia [5].

In addition, the breakdown of political and economic ties stimulated newly independent countries to transform their public systems, including healthcare [6]. Most post-Soviet countries have inherited the Semashko model of primary healthcare system, which presented a centralized and hierarchically high level of governmental management healthcare model [7]. Under this model, all health services were state-funded and free for the country's citizens [7]. The system prioritized the control of communicable diseases, including tuberculosis, typhus, and typhoid fever, emphasizing primary and hospital care. For its time, the Semashko system was a coherent and cost-effective model, significantly contributing to the improved health of Soviet citizens [8]. However, closer to the 1980s, the quality of the Semashko healthcare model began to decline due to underfinanced, in-efficient service provision, poor incentives for providers, and improper management [8,9]. By the time of the USSR's breakup, the system was struggling with a lack of medicines, equipment, and modern technologies, although there was no shortage of medical professionals [8]. These concerns have spurred the search for a new healthcare financing and provision model [10].

The present scoping review aims to discuss the transformation of healthcare systems in nine countries: Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyz Republic (hereafter – Kyrgyzstan), Russia, Tajikistan, Turkmenistan, and Uzbekistan over the period following the dissolution of the USSR, from 1991 to the present. In addition, the review aims to reveal the resulting changes in the health status of the nations under review, with a focus on non-communicable diseases (NCDs), communicable diseases (CDs), maternal and child health, and mental health. Given that all the post-Soviet countries are official members of the World Health Organization (WHO) and have expressed their commitment to achieving the objectives set out by the WHO, the assessment of healthcare system advancement and enhancement was conducted using indicators provided by the WHO [11]. The analysis in the study further focused on examining the progress made by each of the nine post-Soviet nations in achieving the 2030 agenda for the United Nations' Sustainable Development Goal 3 (SDG 3) – good health and well-being, which promotes healthy lifestyles and well-being for all age groups [12]. This review has identified both effective and ineffective ways used by the nine countries, thus offering valuable insights and recommendations for future healthcare reforms and investments.

2. Materials and methods

2.1. Research questions

This scoping review adhered to the technique outlined by Mak and Thomas [13], with the first step being the formulation of two research questions: 1) What transformations have occurred in the healthcare systems of the countries under examination between 1991 and the present? 2) How do these changes relate to the health status of maternal and child health, mental health, CDs, and NCDs throughout the country? The selection criteria for this study aimed to encompass countries that have demonstrated enduring affiliations in the post-Soviet era by actively participating in a range of treaties and unions. These include the Commonwealth of Independent States (CIS), Eurasian Economic Community, Eurasian Economic Union, Economic Cooperation Organization, Eurasian Customs Union, and the Collective Security Treaty Organization. However, Ukraine, Moldova, and Georgia were excluded from the study due to their strong affiliations with the EU and their decision to abstain from participation or withdraw from the aforementioned organizations. Lastly, the research team also searched to see if there was sufficient data available, and if a scoping review had been done on this topic previously. Since there had never been a review conducted on the topic before and there was sufficient data, the team proceeded with the review's preparation.

2.2. Scoping review design

This scoping review utilizes secondary data obtained from multiple sources, including the websites of the WHO, the World Bank (WB), Our World in Data, the Institute for Health Metrics and Evaluation (IHME), the Joint United Nations Programme on HIV/AIDS (UNAIDS), as well as official statistics from Russia, Belarus, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Armenia, and Azerbaijan. Whenever data were accessible and available, they were compared to the mean values specific to the European region as delineated by the WHO. As the review is based on secondary data, there was no requirement to get ethical approval.

2.3. Identifying relevant studies

To conduct a comprehensive search for information related to the study question, a set of key terms was developed. In addition to the names of the countries, the key terms encompassed a range of topics covered by the present review, such as "здравоохранение"

(healthcare), "здоровье" (health), "Медицинский персонал" (health workforce), "оказание Медицинских услуг" (service delivery), "инфорМационные систеМы здравоохранения" (health information systems), "доступ к основныМ лекарстваМ" (access to essential medicines), "финансирование" (financing), "лидерство и управление" (leadership/governance), "рефорМы здравоохранения" (health-care reforms), "всеобщий охват услугаМи здравоохранения" (universal health coverage), "инфраструктура и учреЖдения здравоохранения" (health infrastructure and facilities), "качество Медицинской поМощи" (quality of care), "Цели устойчивого развития" (Sustainable Development Goals), "неинфекционные заболевания" (non-communicable diseases), "инфекционные заболевания" (communicable diseases), "Материнское и детское здоровье" (maternal and child health), "психическое/Ментальное здоровье" (mental health), and COVID-19. The key phrases in English were verified for correctness by doing a cross-reference search utilizing the Medical Subject Headings (MeSH) database. The retrieval of pertinent data was conducted across the following databases: MEDLINE/PubMed, Web of Science, Science Direct, and PsycINFO. The selection of these databases was based on their extensive coverage of research articles published in the domains of global and public health, together with other relevant scientific disciplines. The Google Scholar search engine was used for doing searches in the Russian language, with redirection to Cyberleninka or Elibrary if required. The first fifty search results for each search query were assessed for possible relevance using the Google Scholar search engine.

The review relied on available data between 1991 and the present, incorporating both English and Russian languages. Since the authors were fluent in English, Russian, and Kazakh, searches were restricted to English and Russian to avoid the possibility of introducing bias by including the Kazakh language, which could increase the number of articles from Kazakhstan disproportionately. All searches for this review were carried out between January 1, 2023, and March 21, 2024. The present assessment encompasses the comprehensive evaluation of pertinent data, which encompasses government reports, data sourced from global health agencies, and peer-reviewed publications pertaining to the subject matter. The retrieved data covered various aspects such as the socioeconomic development of Belarus, Russia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Armenia, and Azerbaijan during the post-Soviet period, healthcare reform, healthcare networks, NCDs and CDs, as well as maternal, child, and mental health. The process of data identification and selection was conducted independently by two reviewers (Y.S. and Z.S.). In the event of any disagreement, input from a third reviewer (M.J.) was sought to resolve any discrepancies. The inclusion criteria and data extraction methodology are detailed in the supplementary materials in Appendix 1.

2.4. Data analysis, summary, charting

The primary data derived from the chosen data sources and incorporated studies were subjected to analysis and subsequently categorized into significant themes using an inductive approach. Consistent with the methodology of scoping reviews, the identified evidence was summarized without being subjected to critical evaluation. The data were extracted from global sources such as the WB, the WHO, the IHME, UNAIDS, Our World in Data, and local agencies, including national bureaus of statistics and Ministries of Health (MoH). In addition, relevant studies were also considered in the data extraction process. The data were organized and presented in 12 figures and 5 tables using the 'Chart' tool in Microsoft Excel.

3. Results

The findings are organized according to major themes that emerged during the article search process. This assessment covered these emerging themes pertaining to healthcare reforms, workforce, infrastructure, network, and health indicators in the populations of the countries. Particular emphasis was placed on CDs and NCDs, maternal and child health, and mental health. This assessment also addresses issues that arose during the COVID-19 pandemic and outlines the necessary steps to achieve the SDGs. In order to provide context for the evolution of healthcare systems, we also discussed the socioeconomic changes that transpired after the fall of the Soviet Union.

3.1. Socioeconomic development during the post-soviet era

The economies of post-Soviet countries were heavily dependent on the presence of abundant natural resources, particularly fossil fuels and minerals. Consequently, the most prosperous states in the region were those that possessed abundant resources. In this regard, Russia, Kazakhstan, Uzbekistan, Turkmenistan, and Azerbaijan benefited the most from the extraction and export of minerals, oil and natural gas [14]. Armenia, Kyrgyzstan, and Tajikistan are mountainous countries with few available natural resources and largely underdeveloped manufacturing sectors [15]. Nevertheless, the reliance on natural resources poses certain disadvantages, primarily stemming from the unpredictability of prices in the global markets. In addition, it contributes to increased levels of inequality and subsequently leads to economic stagnation [16]. Russia and Belarus had more diversified economies, better-educated populations, and developed industrial sectors [15].

Following the breakup of the USSR, the countries within the region encountered two major economic shocks: a shift from state-controlled economics to market-oriented economies and a state of hyperinflation. Initial disorganization of national economies resulted from facing the necessity of transitioning from state-controlled economies to market-oriented economics. The situation was made much worse by the interruption of supply chains and shifts in demand caused by the appearance of new national borders and attempts to retain resources within those borders [15]. Similarly, hyperinflation was further intensified by an effort to promote trade by retaining a common currency [17]. Besides, the establishment of new national institutions in the newly independent Central Asian republics was a complex undertaking, particularly due to the absence of any preceding history of national sovereignty [17].

From the beginning of the 2000s, all countries experienced dynamic GDP growth, which serves as a reflection of their respective domestic economic performance. To some extent, this was influenced by the global increase in fossil fuel and mineral resource prices, along with the influx of foreign investments into their domestic economies [15]. These countries exhibited similar trends in the allocation of agriculture, industry, and services as proportions of their respective local economies. Tajikistan had the largest share of agriculture, followed by Armenia and Uzbekistan. Nonetheless, there was a general trend of reducing the agricultural sector's contribution to the overall national economy. The industrial sector experienced a growth in its market share, with Azerbaijan becoming the leading country in the area of this metric, followed by Turkmenistan and Belarus. Services did not significantly contribute to the overall value-added share in the countries under review, although there was a gradual growth in this sector [15]. Fig. 1 illustrates the countries included in the analysis and their respective population sizes as of 2022, as sourced from WB data.

Gross domestic product (GDP): The region's hegemonic power was Russia, which had the highest GDP per capita as well as the largest territory and population size. According to WB data, over the period of 2000–2022, Russia had the highest mean health expenditure per capita, which equaled 500.19 US dollars (USD). In comparison, the second largest economy of the region (Kazakhstan) spent 236.35 USD per capita on healthcare, while the third largest economy (Belarus) spent 282.21 per capita. Meanwhile, the poorest economy (Tajikistan) spent as little as 42.48 USD per capita, on average. However, Armenia had the highest share of GDP in healthcare (8.48 % on average), followed by Kyrgyzstan (6.34 %), and Tajikistan (6.00 %) (Table 1). In general, post-Soviet economies spent relatively little money on healthcare when compared with member countries of the Organization for Economic Cooperation and Development (OECD). During the same time period, the share of GDP in healthcare in Germany constituted approximately 11 %, while that in Italy and Israel constituted approximately 8 % and 7 %, respectively. Yet, other former Warsaw Pact countries (Hungary, Bulgaria, Poland, and Romania) allocated a similar share of GDP on healthcare. In 2021, Hungary spent 7.38 % of its GDP on healthcare, Bulgaria 8.56 %, Poland 6.44 %, and Romania 6.48 % [18].

Life expectancy at birth improved over the period of observation, but it was below the OECD average (77.3 years). As of 2021, the highest life expectancy was seen in Belarus (72.37 years), Armenia (72.0 years), Kyrgyzstan (71.9 years), Tajikistan (71.6 years), and Uzbekistan (70.9 years). The lowest life expectancy was seen in Turkmenistan (69.26 years) [17]. Understanding the age distribution of the population is of great importance, as it guides the planning of health expenditure [19,20]. As of 2022, the bulk of the population in all countries under analysis was composed of adults – individuals aged 15–64 years. However, in the vast majority of countries, the proportion of the child population (0–14 years) exceeded that of the older population (≥65 years). The only exception was Belarus, where there was a nearly equal proportion of people over 65 and children under 15 (17.18 % vs. 16.78 %). Tajikistan was the youngest country in the region, with children making up 36.27 % of the population and seniors making up less than 3.47 % of the population (Fig. 2).

In addition, the **Human Capital Index** (HCI) is a useful utility that depicts human capital loss due to a lack of education and health. In 2020, Russia was ranked 41 out of 173 countries, while Tajikistan was ranked 111. It could be deduced that significant gaps in
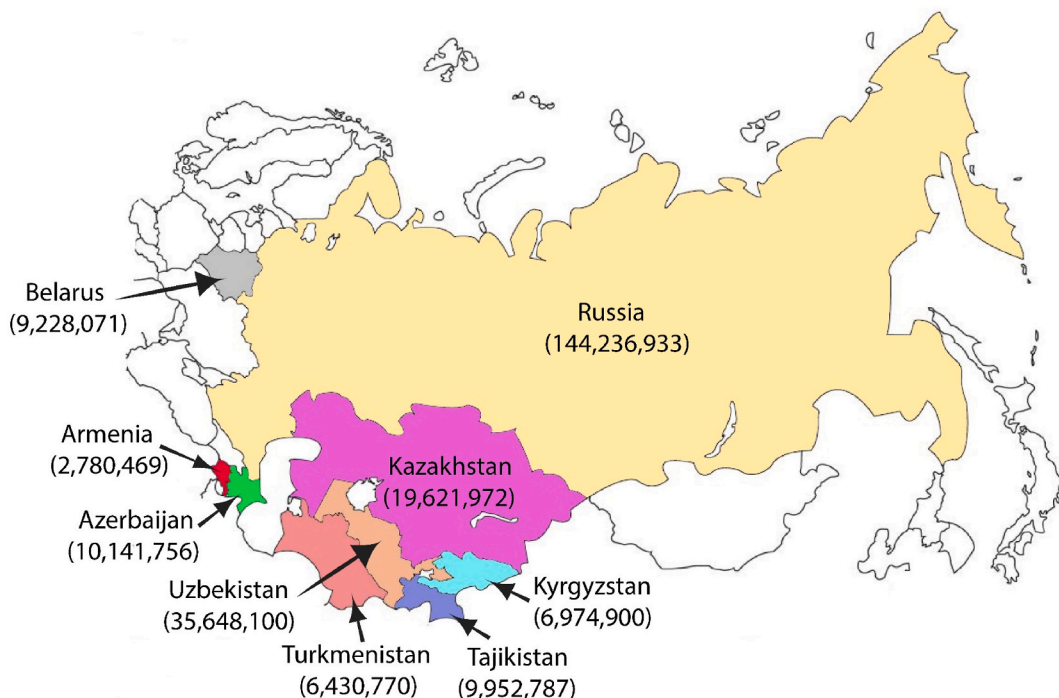
Fig. 1. Review of countries included in the analysis and their population sizes as of 2022 Charting was performed based on the data obtained from the World Bank [18].

Table 1

Gross domestic product and health expenditure per capita, 2000–2022.

Country (2022 income level)	Indicator	Mean	Median	Minimum – maximum	Average change per annum (95 % CI)
Armenia (upper-middle income)	GDP per capita (USD)	3167.60	3591.83	622.74–7018.05	9.59 % (7.33–11.89 %)
	Health expenditure per capita (USD)	280.73	313.90	26.13–612.78	14.52 % (11.77–17.34 %)
	Health expenditures as a percentage of GDP per capita (%)	8.48	9.18	4.20–12.34	4.47 % (3.46–5.48 %)
Azerbaijan (upper-middle income)	GDP per capita (USD)	4315.17	4739.84	655.12–7762.07	10.26 % (6.35–14.31 %)
	Health expenditure per capita (USD)	131.86	150.47	19.14–267.31	14.01 % (10.50–17.64 %)
	Health expenditures as a percentage of GDP per capita	3.08	2.85	1.93–4.70	3.07 % (1.77–4.39 %)
Belarus (upper-middle income)	GDP per capita (USD)	5191.41	5967.07	1244.37–8341.29	7.86 % (5.45–10.33)
	Health expenditure per capita (USD)	282.21	317.42	55.50–467.52	8.67 % (6.15–11.25 %)
	Health expenditures as a percentage of GDP per capita	5.69	5.69	4.87–6.56	0.40 % (−0.04 to 0.85 %)
Kazakhstan (upper-middle income)	GDP per capita (USD)	7767.51	9070.49	1229.00–13890.63	9.55 % (6.45–12.74 %)
	Health expenditure per capita (USD)	236.35	260.01	51.00–402.98	9.26 % (6.56–12.03 %)
	Health expenditures as a percentage of GDP per capita	3.29	3.23	2.61–4.15	0.82 % (−1.80 to −0.17 %)
Kyrgyzstan (lower-middle income)	GDP per capita (USD)	931.15	1120.67	279.62–1655.07	7.93 % (6.41–9.46 %)
	Health expenditure per capita (USD)	58.21	62.92	12.29–104.78	8.38 % (5.35–11.50 %)
	Health expenditures as a percentage of GDP per capita	6.34	6.47	4.27–8.49	0.27 % (−1.24 to 1.81 %)
Russia (upper-middle income)	GDP per capita (USD)	9343.75	10194.44	1771.59–15974.64	8.25 % (5.34–11.24 %)
	Health expenditure per capita (USD)	500.19	540.97	95.41–935.73	9.31 % (6.55–12.14 %)
	Health expenditures as a percentage of GDP per capita	5.34	5.17	4.77–7.39	1.14 % (0.41–1.88 %)
Tajikistan (lower-middle income)	GDP per capita (US$)	679.86	807.10	138.43–1054.19	8.66 % (6.34–11.03 %)
	Health expenditure per capita (USD)	42.48	46.32	5.97–74.60	12.26 % (9.58–12.01 %)
	Health expenditures as a percentage of GDP per capita	6.00	5.89	4.31–8.01	2.89 % (2.61–3.17 %)
Turkmenistan (upper-middle income)	GDP per capita (USD)	4760.80	5649.96	643.18–8792.55	12.18 % (9.82–14.59 %)
	Health expenditure per capita (USD)	328.98	332.20	76.64–565.26	6.81 % (4.68–8.98 %)
	Health expenditures as a percentage of GDP per capita	4.64	4.90	4.78–6.26	1.13 % (−0.58 to 2.87 %)
Uzbekistan (lower-middle income)	GDP per capita (USD)	1498.28	1742.35	383.34–2753.97	9.11 % (6.48–11.80 %)
	Health expenditure per capita (USD)	79.90	83.86	24.48–157.19	8.99 % (6.78–11.25 %)
	Health expenditures as a percentage of GDP per capita	5.21	5.10	4.48–7.74	0.86 % (0.02–1.70 %)

Charting was performed by creating a custom table based on the data obtained from the World Bank [18].
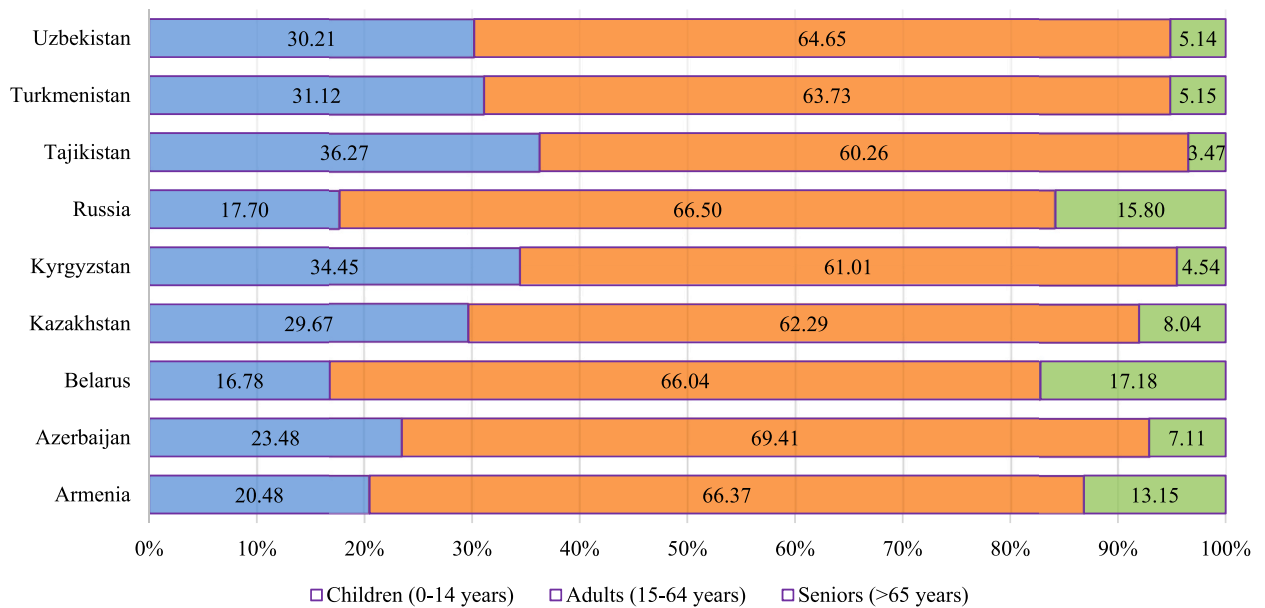
human capital outcomes existed across post-Soviet countries. Due to the high proportion of children, there was a need to focus efforts on the promotion of primary healthcare, nutrition, vaccination, early child development, and other essential services [17].

3.2. Healthcare reform

Most former Soviet republics went through a process of reforming that resulted in mass privatization [3]. This was not an exception for the healthcare sector, as privatization of state-owned health facilities was extensively practiced during the 1990s in some countries [21]. As most medical professionals were low-paid workers and since the healthcare sector was largely underfinanced, medical corruption was very common during that time period [22].

However, a decade later, governments started implementing a systematic approach to healthcare reform by designing a series of health plans. The strategies were targeted on the strengthening of primary and specialized medical care, health promotion and disease prevention, accessibility and affordability of medical services, as well as control of CDs and NCDs [23]. In Russia, Azerbaijan, and Kazakhstan, the emphasis was also placed on the modernization of hospital infrastructure and the introduction of technological innovations [24]. Nevertheless, unlike the former socialist economies of Central Europe, only a limited foreign investment to healthcare reform was provided [25]. Yet, the Semashko model legacy greatly influenced the organization and governance of healthcare systems, even three decades after the fall of the USSR. This influence persisted due to a combination of underinvestment, lack of political commitment, and the retention of most aspects of the USSR healthcare system. In this regard, the MoH played a pivotal role in shaping health policies and legislation. Apart from strategic planning efforts, the MoH carried out organization and management initiatives within the healthcare sector, but with limited delegation of decision-making authority to local health authorities. The process of decentralization was implemented gradually, primarily focusing on administrative issues. Public involvement in the development of health policies was insufficient, as indicated by the European Commission guidelines, which also highlighted the inadequate consideration of patient rights regarding the protection of personal information [26]. Moreover, these countries exhibited over-reliance on large hospitals, leading to an inequitable and ineffective distribution of healthcare resources, resulting in subpar quality of medical services [23,24].

Age structure of population

Country	Children (0-14 years)	Adults (15-64 years)	Seniors (>65 years)
Uzbekistan	30.21	64.65	5.14
Turkmenistan	31.12	63.73	5.15
Tajikistan	36.27	60.26	3.47
Russia	17.70	66.50	15.80
Kyrgyzstan	34.45	61.01	4.54
Kazakhstan	29.67	62.29	8.04
Belarus	16.78	66.04	17.18
Azerbaijan	23.48	69.41	7.11
Armenia	20.48	66.37	13.15

Fig. 2. Age structure of population (both sexes), 2022 Charting was performed by creating custom charts based on the data obtained from the World Bank [18].

In general, a prevalent characteristic of healthcare reforms was the institution of five-year health plans, echoing a convention of the Soviet economic framework [27]. These reforms shared similarities, and during the 1990s, they were rather chaotic responses to the unfolding socioeconomic crisis. Due to a deficiency in public health funds, there was both an informal and formal reinforcement of out-of-pocket (OOP) payments. The reforms in the 1990s were primarily geared towards enhancing financial sustainability and fortifying the governance of the healthcare system [23]. Beginning in the early twenty-first century, there was an emphasis on combating CDs and reducing maternal and infant mortality. In addition, throughout the 2000s, governments prioritized strengthening primary healthcare services and introducing family medicine [24]. Health information systems also were introduced during the 2010s. During the same time frame, programs aimed at preventing and controlling NCDs, with an emphasis on cardiovascular disease (CVDs), were implemented [27]. The review's subsequent subsections will provide greater detail on healthcare reforms implemented in the countries during the period under consideration. Table 2 provides an overview of the healthcare reforms implemented in each country.

Healthcare expenditures: Healthcare finance changes also were undertaken by all post-Soviet nations. During the 1990s, payments to healthcare providers also followed the Soviet model of healthcare budgeting. Under this model, line-item budgets were utilized, and there was little room for the reallocation of financial resources, significantly limiting managerial autonomy [23]. All countries in the region introduced per capita payments for primary healthcare services, and most countries also employed capitation for hospital services, with the exception of Tajikistan. Diagnosis-related groups or clinical cost groups were introduced for hospital care payments [27]. As a result of a limited healthcare budget, Azerbaijan, Russia, Kazakhstan, and Kyrgyzstan implemented obligatory health insurance systems, while numerous other nations expressed intentions to adopt similar measures in the foreseeable future [26]. Nevertheless, these nations implemented a strategy of offering economic assistance to socially marginalized groups within society, including children, expectant mothers, senior people, and persons without employment. This financial support was funded by health taxes contributed by working individuals [23]. The allocation of healthcare funds was subject to regulation by the MoH and the funds were used for purchasing medical services from healthcare organizations [23,39]. Private or voluntary health insurance was largely nonexistent, primarily due to the limited financial resources of the majority of people, which hindered their ability to afford and get comprehensive healthcare coverage [23]. Nevertheless, the coverage provided by private or voluntary health insurance was notably higher in major urban areas [23].

Due to a constrained allocation of public funds toward healthcare, health services were primarily funded through public sources and OOP payments. The share of OOP payments in the total structure of health expenditures notably increased during the 1990s, following a socioeconomic crisis. In most countries in the region, this share began to decline in the early 2000s and continued to decrease further after the 2010s [24]. Nevertheless, OOP payments exceeding 20 % of health expenditures are considered problematic, as this undermines sustainability and predisposes individuals to catastrophic health expenditures in a public health emergency situation [40]. Out of the selected countries, Belarus, Russia and Kazakhstan had the highest share of public spending on healthcare, exceeding 50 % of all expenditures. Over the period of 2000–2021, this share remained stable, and the average growth per annum equaled 0.41 % (95 % confidence interval (CI) 0.03–0.78 %) for Russia, 0.47 % (95 % CI -0.94 to 0.00 %) for Belarus, and 0.53 % (95 % CI -0.12 to 1.19 %) for Kazakhstan. In countries with a low proportion of public spending on healthcare, foreign transfers were

Table 2
Key features of healthcare reform in Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, and Uzbekistan during 1991–2023.

Country, references	Specific features	Principles of reform during 1990–2000	Principles of reform during 2000–2010	Principles of reform from 2010 onward
Armenia [21, 22,28,29]	Healthcare reform was delayed by a war conflict with Azerbaijan and devastating earthquake in Spitak.	The shift of healthcare from hospitals to ambulatory settings has been observed. The integration of specialist services has taken place in healthcare. There has been a decentralization of healthcare management.	Reforms were implemented to change the principles and forms of healthcare financing. The introduction of health insurance was a key reform. Reforms aimed at enhancing the quality and comprehensiveness of primary care were initiated, and the first family practitioners and nurses were trained. The practice of free choice of a doctor was introduced. The establishment of the Public Health Emergency Operation Center was a significant development.	Continual efforts were made to improve the quality of primary care. Guidelines for the treatment of common infections were introduced, with an emphasis on the rational use of antibiotics. Improvements were made in public health surveillance and the quality and efficiency of the laboratory system. Strategies to control noncommunicable diseases, including the promotion of healthy lifestyles, were implemented. Efforts to improve reproductive health were made.
Azerbaijan [21–23,30]	Healthcare reform was delayed by a war conflict with Armenia.	The shift of healthcare from hospitals to ambulatory settings has occurred. The integration of specialist services has been implemented. Rationalization of small healthcare units has taken place.	National plans were developed and implemented. Improvements in public health surveillance were introduced, and malaria was brought under control. Laboratory surveillance was enhanced. Reforms were implemented in medical education and healthcare workforce management.	Strengthening the capacity of primary healthcare has been a priority. Efforts have been made to improve emergency preparedness. There has been a focus on improving the quality of health information systems. Continuous efforts have been made to enhance reproductive, maternal, and child health. The network of specialized healthcare facilities has been expanded. Provisions have been made to introduce health insurance.
Belarus [22,23, 31]	Healthcare reform underwent a lengthy process of discussion, testing through pilot projects, and then implementation.	Healthcare shifted from hospitals to ambulatory settings. Bed capacity was reduced.	All human and material resources in healthcare were unified under a single management to enable more rational use. High-technology forms of medical care were introduced and included in the standard package of medical services.	International standard classifications were introduced for basic indicators, laying the foundation for health financing reform. Preventive services were developed. Reproductive health services were improved. A new pharmaceutical regulator was established to attract international investments and upgrade the domestic pharmaceutical industry. Health insurance was introduced.
Kazakhstan [21–23,32]	While healthcare reform has been slow, the healthcare system was considered one of the most progressive in the region.	The first health insurance scheme was introduced, but it was not sustainable due to corruption issues. The privatization of pharmacies, rehabilitation units, and dentistry services took place.	Capacity building of health professionals in areas such as maternity and child care, as well as HIV and tuberculosis prevention and care. High-technology forms of medical care were introduced and made available at the national capital level.	Another attempt to implement health insurance was undertaken. Activities were carried out to promote evidence-based clinical practice. Reforms in higher medical education were initiated. High-technology medical care was extended to the regional capital level.
Kyrgyzstan [21–23,33]	The country received a significant influx of foreign aid and advice, but healthcare reform was hindered by periods of political instability.	Healthcare shifted from hospitals to ambulatory settings. The closure of large facilities and the opening of many smaller ones.	Efforts were made to strengthen primary care. Improvements were made in public health surveillance, as well as in the quality and efficiency of the laboratory system. Strategies were implemented to	Regulation of prices for a list of selected medicines was implemented. Efforts were made to improve the management of selected non-communicable disorders at the primary care level.

Table 2 (*continued*)

Country, references	Specific features	Principles of reform during 1990–2000	Principles of reform during 2000–2010	Principles of reform from 2010 onward
		Bed capacity, particularly at rural facilities, was reduced.	control communicable diseases. There was a strengthening of maternity and child care. Adoption of a basic benefits package.	Health insurance was introduced. Provisions were put in place to enhance the quality of healthcare services and increase healthcare funding.
Russia [8,21, 22,34]	Healthcare reforms were slow and often incomplete. There is a considerable diversity in health outcomes across different geographical regions.	A shrinkage of public health expenditure occurred due to a socio-economic crisis, resulting in a widespread use of out-of-pocket payments. Introduction of health insurance. Although a shift to a GP model was declared, the implementation was highly inconsistent. Provisions were put in place to reduce the dominance of healthcare providers and enhance their responsiveness to consumer preferences.	The launch of administrative reform focused on redistributing responsibilities among various administrative levels, including the redistribution of financial resources. The adoption of the 'Monetization of Benefits' Law targeted beneficiary population groups by providing free outpatient prescription medications. High-technology forms of medical care were introduced at the level of regional capitals. Efforts were made to strengthen maternity and child care services.	Efforts were made to strengthen primary care and balance the allocation of financial resources between primary care and specialist care. A quality management system based on medical care rules and standards was introduced. Efforts were made to reduce mortality from cardiovascular diseases, road traffic accidents, cancer, and to control HIV/AIDS and tuberculosis. Improvements were implemented in the care of low-weight newborns, the development of neonatal surgery, and the establishment of a palliative care system for children.
Tajikistan [21–23,35, 36]	Healthcare reform was delayed due to civil war and political instability.	A reduction in the number of healthcare facilities occurred due to extensive war damage. Pharmacies and dental care facilities were privatized. Basic services were provided by foreign aid agencies.	Development and implementation of a national strategy to control non-communicable disease. Efforts to control communicable disease, including tuberculosis. Efforts to reorient the health system towards primary care. Adoption of a basic benefits package.	The introduction of a state-guaranteed basic benefits package. The introduction of per capita health financing. The establishment of a Mandatory Health Insurance Fund. Efforts were made to improve the prevention of cardiovascular diseases at the primary care level. Investments were made in health facilities and technologies.
Turkmenistan [21–23,36, 37]	Highly centralized government. The country is internatonally isolated.	Adoption of the presidential health program (Lukman). Introduction of voluntary health insurance. Introduction of integrated primary care services.	Introduction of a nominal system. Reform of higher medical education, including the reduction of the duration of training and subsequent elongation. Closure of rural hospitals with dismissal of medical professionals.	Investments were made in health infrastructure. Reopening of rural hospitals. Introduction of an annual Month of Health and Sports, promoting healthy lifestyles. Efforts were made to improve the treatment of non-communicable and communicable diseases, maternity and child care.
Uzbekistan [21–23,38, 36]	Healthcare reforms were slow.	Pharmacies, opticians, and dental care facilities were privatized. Introduction of health insurance. Gradual decentralization of healthcare system. Adoption of a basic benefits package.	Transformation of rural primary healthcare services into rural physician points and outpatient clinics at central rayon hospitals. Improvements in maternal and child care. Adoption of the WHO Package of Essential Noncommunicable Disease protocols.	Introduction of a health management information system. Implementation of health financing reform. Improvement of the training of health professionals. Revision of service delivery models, including multidisciplinary facilities. Strategies to control non-communicable and communicable diseases.

practiced. These contributed to 7.86 % of all health expenditures in Tajikistan, on average, 6.51 % in Kyrgyzstan, and 5.33 % in Armenia. The proportion of OOP payments was considerable in all countries, reaching 74.47 % in Armenia, 70.42 % in Turkmenistan, and 68.36 % in Tajikistan, on average. In Belarus, the average rate of OOP payments was the lowest (29.85 %) and showed a downward trend (average decline per annum was 0.98 % (95 % CI -0.20 to 2.17 %) (Fig. 3) [39].

3.3. Healthcare network

Healthcare facilities were available across different levels, typically consisting of a hospital and multiple polyclinics in urban areas, to serve the first-contact outpatient facilities for urban residents. The provision of healthcare services in rural areas was undertaken by

Structure of health expenditure
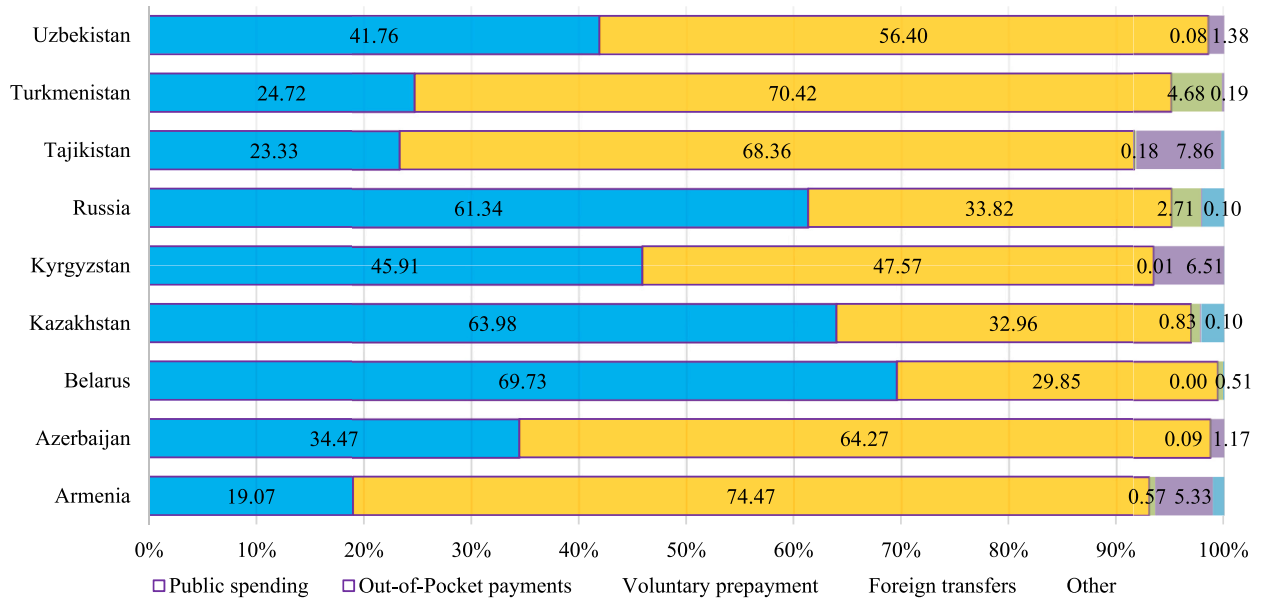
Fig. 3. Structure of healthcare expenditure (average percentage), 2000–2021 Charting was performed by creating a custom chart based on the data obtained from the WHO [39].

the Feldsher/Midwife Health Posts (FHPs) [24]. At the regional level, there were operational secondary care facilities that comprised specialist hospitals and dispensaries. These establishments offered healthcare services targeting specific health disorders, including malignant neoplasms, tuberculosis, and sexually-transmitted infections. Tertiary care facilities were predominantly concentrated in the capital cities of nations, providing an elevated standard of specialist medical treatments, encompassing, among others, neurosurgery and cardiac surgery [23]. A salient feature of the healthcare network was the existence of parallel healthcare systems, a situation that can be attributed to the historical impact of the USSR. Supplementary healthcare systems, commonly associated with national railways and the Ministry of Education, coexisted alongside the required healthcare system established by the MoH [24,25]. While few countries, such as Belarus, have undertaken initiatives to incorporate their parallel healthcare systems into the statutory system, the majority of countries have chosen to retain these systems [25]. In most countries, the reform of the healthcare network largely focused on the transformation of polyclinics into Family Medical Centers (FMC). This process began in the late 1990s and continued until the end of the period covered by this review. The resulting network of outpatient healthcare facilities was broader than the original one, and the retrained outpatient internal medicine physicians and pediatricians constituted the bulk of the family physician workforce [24]. The number of polyclinics had a decline, resulting in an increase in their size, and a predominant concentration in city districts (usually one per district) or in sizable rural settlements [23]. The underlying justification for adopting this particular technique was to mitigate the financial burden of healthcare expenses amidst an ongoing socioeconomic crisis, while also facilitating the achievement of universal health coverage [25].

Hospital infrastructure and equipment: In the majority of post-Soviet states, hospital facilities and hospital-based physicians were the mainstays of the healthcare system [23]. These systems prioritized curative care over health promotion, health education, and the creation of healthy living environments. Most illness management clinical techniques were outdated for that time period. Even if outpatient parenteral treatment may replace intravenous and intramuscular injections, extensive regimens were still used. The consequence of these approaches resulted in a disproportionate dependence on hospital facilities. Nevertheless, while the considerable quantity of hospital beds that were accessible, they sometimes experienced low occupancy rates due to an oversupply that was beyond the actual need [25]. Thus, all nations in the area have reduced hospital numbers and beds [23]. Bed reduction was greatest in Azerbaijan (-4.10 % per year, 95 % CI: -4.79 to -3.40 %) and Russia (-2.31 %, 95 % CI: -2.92 to -1.71 %) [41,42]. Most government-run and rural hospitals closed, while privately operated hospitals and beds increased. Even after reduction, Russia [43] and Belarus [44] have more beds than the 2022 regional average of 530.9 beds per 100,000 inhabitants. Many nations boosted hospital capacity because of the COVID-19 pandemic, but Kazakhstan did the most, increasing bed density from 529 per 100,000 people in 2019 to 670.0 in 2020 [45]. In Armenia, Kyrgyzstan, Tajikistan, and Uzbekistan, the hospital capacity was lower than in other countries of the area and below the EU and WHO European average. Armenia had 407.0 beds per 100,000 inhabitants in 2022 [41], Kyrgyzstan had 390.0 beds [46,47], Uzbekistan had 463 beds [48], while the EU countries on average had 500 beds [35] (Fig. 4a). Besides, the hospital infrastructure in Kyrgyzstan and Tajikistan was considered to be outdated, primarily due to underinvestment in the healthcare systems during the past few decades. Despite the receipt of foreign aid, numerous health facilities faced deficiencies in essential amenities such as heating, water, and sanitation [23]. During the past decade, central governments of many of the listed
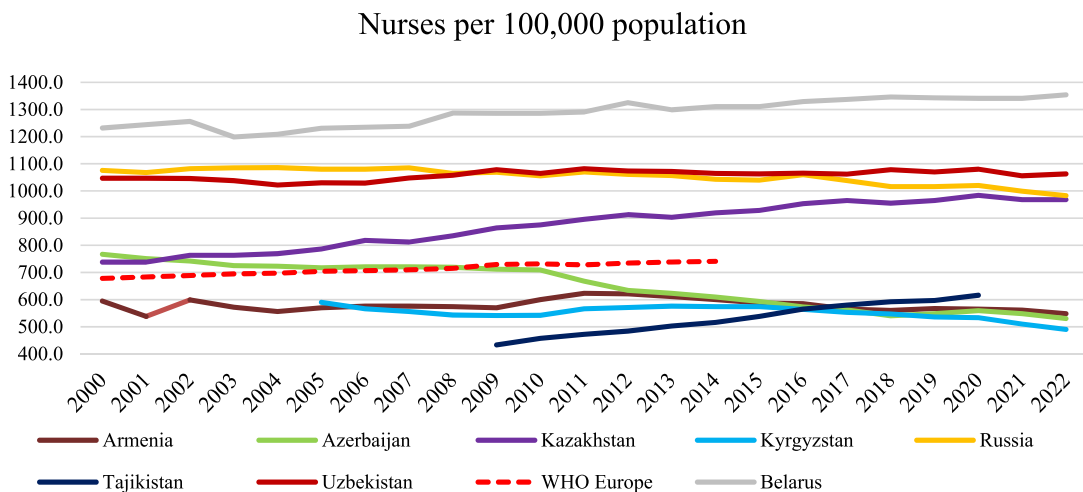
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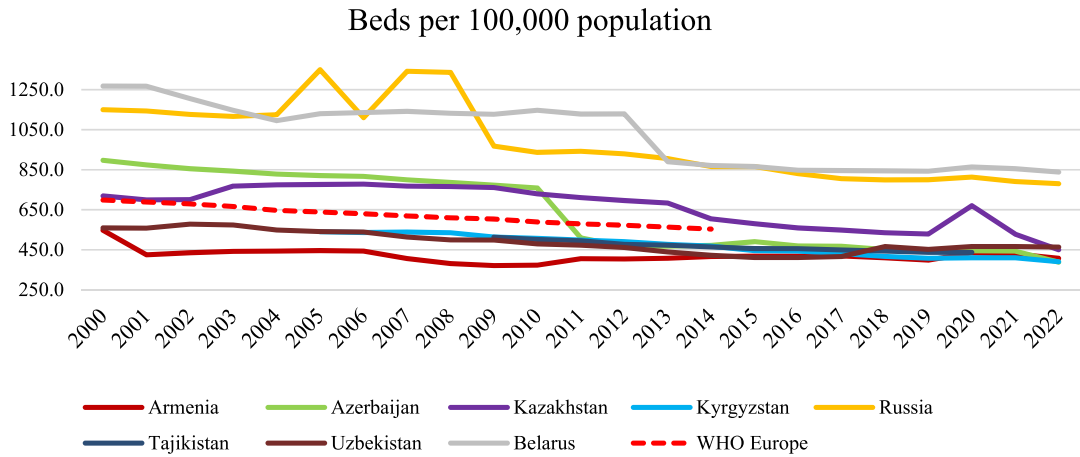
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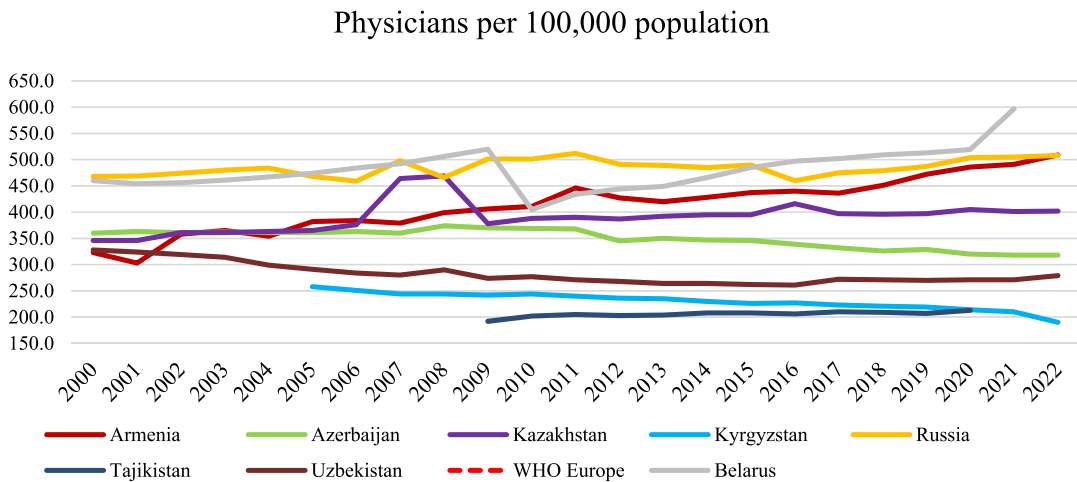
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Fig. 4. The number of beds **(a)**, physicians **(b)**, and nurses **(c)** per 100,000 population, 2000–2022. Charting was performed by creating a custom chart based on the data obtained from the national statistical agencies of Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan and Uzbekistan [18,41–48,50].

countries have made substantial investment in refurbishment hospital infrastructure. These improvements were particularly significant for Russia, Kazakhstan, and Azerbaijan. Given the increasing burden of CVD and malignant neoplasms, there was a distinct emphasis on the development of facilities dedicated to those treatments. The majority of this process of modernization was concentrated on larger hospitals; nevertheless, there have been new initiatives to expand these advancements to larger rural hospitals [49].

Health professional-to-population ratio: The physician density was significantly higher than the WHO European region average in all the countries covered by the review. These countries had a well-established network of medical schools that provided training to future doctors, who specialized already during their undergraduate training, earning qualifications as "physicians," "pediatricians," or "dentists." However, in most cases, physicians performed basic tasks, which in developed countries were traditionally carried out by nurses. For instance, pediatricians in polyclinics primarily monitored child growth and development, referring children to hospital facilities in case of illness [25]. Starting in the 2000s, most countries in the region made efforts to align their medical education systems with European standards by joining the Bologna process. As a result, graduates of medical schools acquired the qualification of a primary care physician [23]. However, some countries, such as Russia and Turkmenistan, retained the traditional Soviet model of medical education up to this day [23]. Russia, Belarus, Armenia, and Kazakhstan had more doctors than other nations. Belarus had 598.0 doctors per 100,000 people in 2022, Russia 508.0, Armenia 509.0, and Kazakhstan 402.0. The number of doctors in Kyrgyzstan was significantly below the regional average (190.0 per 100,000 inhabitants in 2022), and it constantly fell. The average annual drop was 1.30 % (95%CI: −1.53 to −1.06 %) from 2000 to 2022 (Fig. 4b). The issue may be attributed to professional medical professionals moving to Russia and Kazakhstan for better pay. The lack of private medical schools in Kyrgyzstan and Tajikistan may also contribute to the shortage of medical professionals 49]. In addition, nurses have played a significant role in the delivery of healthcare services in post-Soviet countries. They were involved in basic health activities, including immunization, health education, and the provision of antenatal and prenatal care. In many rural areas, nurses and feldshers frequently constituted the exclusive healthcare providers, working within the framework of FHPs. Although each country included in this review had a substantial nursing workforce, their skill levels were often lower in comparison to nurses in developed countries. As a result, nurses typically performed less complex duties, and the transfer of nursing responsibilities to physicians was common [25]. Over the 20-year period from 2000 to 2022, Azerbaijan experienced a decrease in the nurse-to-population ratio from 767 to 530 per 100,000 individuals, indicating an average annual decline of −1.79 %. However, nurses were plentiful in Belarus, Russia, Kazakhstan, and Uzbekistan, with rates above the WHO European region average 35]. Similarly, Kazakhstan experienced an increase in the nurse-to-population ratio from 738.0 to 968.0 per 100,000 individuals, reflecting an average annual growth of 1.43 % (95%CI: 1.28–1.57 %) (Fig. 4c).

Urban-rural disparities: Regional disparities in the distribution of the medical personnel were pronounced in post-Soviet states, with physicians primarily concentrated in urban areas and a dearth of health professionals in rural areas. To address this issue, local authorities implemented a range of incentives to encourage medical professionals to work in rural areas. Tajikistan's MoH requires medical school graduates to work in rural regions for at least three years [51]. In 2015, the Russian government issued a decree mandating that all medical school graduates could only practice as primary care physicians, and that in order to become specialists, they required at least one year of exposure as a primary care physician. Enrollment in specialty training programs was easier for graduates who practiced in rural locations [52]. In 2009, the Kazakhstan government began rewarding doctors who relocate to rural areas to practice. This program included a relocation allowance and mortgage at a reduced rate [53]. Rural physicians in Uzbekistan received additional monetary compensation in addition to their salaries [54]. In 2006, the "physician deposit" was implemented in Kyrgyzstan for medical professionals relocating to rural areas. This deposit included monthly contributions into a special account, with 50 % of the funds available after one year of rural practice, and the remaining 50 % accessible after three years [55]. Given the global trend of health professionals preferring to work in urban areas [56], continuous efforts are needed to stimulate health professionals to work in rural and remote areas. Since most nations struggle to recruit and retain distant health workers, incentive programs should be supported with adjustments to training, staff management, working environment, and housing [56]. Due to a significant proportion of the population in many of the countries under review resided in rural areas, the disparity in the distribution of the professional workforce affected a sizable share of the population.

3.4. The burden of non-communicable disease

Non-communicable diseases are now the leading cause of mortality in many countries around the globe [57], and post-Soviet states are no exception [23]. NCDs significantly contributed to low life expectancy in the former USSR, which fell below the life expectancy compared to the WHO European region. Significant disparities in NCDs are primarily attributable to the substantial burden of premature mortality, particularly among individuals aged 30–70 years, with a particular emphasis on males [23]. The mortality rates associated with CVD and external causes, such as poisoning and traumas, exhibited notable elevations among middle-aged males residing in rural and semi-rural regions with a low socioeconomic standing [58]. Out of all former Soviet economies, Russia exhibited notably elevated levels of male mortality in comparison to other countries at similar stages of development [19]. The male mortality paradox [59] can be attributed primarily to alcohol consumption and mental discomfort. Additional nations within the post-Soviet bloc have also shown elevated male death rates among ethnic Russians due to the consumption of harmful amounts of alcohol [32].

Life expectancy due to NCDs started declining in the first half of the 1990s shortly after the USSR dissolution. This decline was the most dramatic in Russia, but other countries followed a similar trend with a substantial decline and a subsequent slow recovery [23]. There has been a significant increase in life expectancy since the beginning of the twenty-first century. Nevertheless, a gender disparity persists, particularly in Armenia, Russia, Belarus, and Kyrgyzstan, where it is most evident. On the basis of recent data from 2021, a significant discrepancy in life expectancy between females and males has been observed in certain countries. The difference in life expectancy between women and men has reached 10.8 years for Armenia, 10.6 years for Russia, 10.4 years for Belarus, and 8.6 years

Table 3
The leading causes of mortality from non-communicable diseases per 100,000 population, 2019.

Country	Major diagnostic categories	Top diagnoses	Mortality rate	Lower limit	Upper limit	Overall rank	Change in relation to 2000 (%)
Azerbaijan	CVD[a]	Ischemic heart disease	264.71	231.83	302.54	1	9.15
		Stroke	104.32	86.52	123.33	2	33.63
		HHD[b]	18.86	13.65	25.70	6	−5.28
	Neoplasms	Lung cancer	22.34	16.41	28.41	4	55.52
		Stomach cancer	18.27	15.14	22.13	7	4.37
		Colorectal cancer	10.34	8.51	12.69	11	78.52
	Digestive diseases	Cirrhosis	30.33	24.62	37.23	3	−2.54
		Diabetes mellitus	20.92	17.21	25.24	5	31.91
Armenia	CVD	Ischemic heart disease	306.05	260.96	353.93	1	25.54
		Stroke	88.32	74.15	103.02	2	−11.42
		HHD	21.83	8.79	26.80	8	101.67
	Neoplasms	Lung cancer	44.17	37.14	52.24	3	21.88
		Colorectal cancer	19.38	16.30	22.54	9	47.4
		Breast cancer	18.48	15.39	21.33	10	−5.04
	Digestive diseases	Diabetes mellitus	40.89	34.20	47.70	4	8.34
		Cirrhosis	36.90	31.11	43.08	6	143.13
Belarus	CVD	Ischemic heart disease	574.88	472.26	701.66	1	11.49
		Stroke	177.95	143.36	219.37	2	−10.04
		Cardiomyopathy	14.75	10.75	21.50	11	0.42
	Neoplasms	Lung cancer	44.17	37.14	52.24	3	21.88
		Colorectal cancer	19.38	16.30	22.54	9	47.4
		Breast cancer	18.48	15.39	21.33	10	−5.04
	Neurological disorders/ substance abuse	Alzheimer's disease	38.79	9.45	102.61	3	62.36
		Alcohol use disorders	31.29	23.85	40.62	5	18.39
Kazakhstan	CVD	Ischemic heart disease	179.68	156.43	203.14	1	−42.4
		Stroke	127.05	109.47	144.11	2	−19.49
		Cardiomyopathy	25.30	8.67	32.78	5	209.2
	Neoplasms	Lung cancer	20.21	17.31	23.17	6	27.98
		Stomach cancer	13.07	11.37	14.98	8	−34.74
		Colorectal cancer	11.91	10.36	13.54	10	3.41
	CRD[∞]	COPD[c]	43.78	36.59	51.90	3	29.77
		Asthma	6.85	5.05	8.76	17	−24.44
Kyrgyzstan	CVD	Ischemic heart disease	175.70	156.10	195.30	1	−11.88
		Stroke	70.23	62.10	79.59	2	−47.42
		HHDse	7.83	6.02	9.33	8	−4.23
	Neoplasms	Stomach cancer	11.77	10.25	13.35	5	−20.19
		Lung cancer	8.57	7.43	9.73	7	−15.69
		Colorectal cancer	5.29	4.64	6.03	13	−10.6
	Digestive diseases	Cirrhosis	32.79	28.74	37.49	3	−1.82
		Diabetes mellitus	4.92	4.28	5.63	14	−15.33
Russia	CVD	Ischemic heart disease	383.46	333.17	431.42	1	−15
		Stroke	223.48	193.95	250.82	2	−29.18
		Cardiomyopathy	36.04	22.27	44.11	4	13.81
	Neoplasms	Lung cancer	36.90	31.44	43.01	3	−12.52
		Colorectal cancer	29.20	25.65	32.99	7	11.97
		Stomach cancer	21.07	18.40	24.02	9	−36.19
	Digestive diseases	Cirrhosis	31.42	27.03	36.13	6	38.21
		Diabetes mellitus	12.78	11.14	14.52	13	80.14
Tajikistan	CVD	Ischemic heart disease	142.35	119.74	171.17	1	−0.91
		Stroke	62.23	50.41	76.06	2	−19.52
		HHD	16.96	10.65	21.19	6	−20.48
	Neoplasms	Stomach cancer	12.04	9.77	14.88	7	3.03
		Lung cancer	6.17	5.02	7.71	9	12.7
		Breast cancer	4.69	3.64	5.97	13	25.93
	Digestive diseases	Cirrhosis	23.05	18.66	26.47	3	11.27
		Diabetes mellitus	17.44	13.82	21.68	5	111.91
Turkmenistan	CVD	Ischemic heart disease	222.40	183.80	270.64	1	4.5
		Stroke	103.55	84.20	126.55	2	65.03

Table 3 (*continued*)

Country	Major diagnostic categories	Top diagnoses	Mortality rate	Lower limit	Upper limit	Overall rank	Change in relation to 2000 (%)
		Cardiomyopathy	14.65	11.27	20.24	5	−22.97
	Neoplasms	Lung cancer	7.85	6.22	9.91	10	35.46
		Esophageal cancer	7.46	5.87	9.29	11	4.44
		Stomach cancer	7.07	5.62	8.86	13	−5.42
	Digestive diseases	Cirrhosis	46.84	37.88	58.40	3	64.19
		Diabetes mellitus	74.43	11.89	18.90	4	74.43
Uzbekistan	CVD	Ischemic heart disease	224.19	195.11	255.53	1	−1.63
		Stroke	74.30	63.53	87.09	2	−26.84
		HHD	9.39	6.20	12.72	6	25.93
	Neoplasms	Stomach cancer	8.18	6.79	9.56	7	−24.74
		Lung cancer	7.89	6.50	9.44	8	−8.82
		Breast cancer	6.69	5.48	8.03	9	18.9
	Digestive diseases	Cirrhosis	38.73	32.30	45.91	3	8.04
		Diabetes mellitus	24.21	20.18	28.41	4	86.59
WHO Europe	CVD	Ischemic heart disease	247.00	223.13	263.69	1	−7.73
		Stroke	126.27	112.83	134.92	2	−15.16
		HHD	22.04	15.26	24.46	9	93.16
	Neoplasms	Lung cancer	49.78	46.83	52.27	3	10.94
		Colorectal cancer	32.83	30.16	34.75	6	27.8
		Breast cancer	18.30	16.65	19.48	12	9.28
	Neurological disorders	Alzheimer disease	44.78	11.16	115.88	4	95.45

Charting was performed by creating a custom table based on the data obtained from the IHME for 2019 [62].

∞CRD – Chronic respiratory diseases.

[a] CVD – Cardiovascular Disease.

[b] HHD – Hypertensive Heart Disease.

[c] COPD – Chronic Obstructive Pulmonary Disease.

for Kyrgyzstan [60]. Most of the gains in life expectancy could be attributed to reductions in mortality from infectious diseases, respiratory conditions, and to a certain extent, CVD [24]. In addition to harmful alcohol consumption, a high prevalence of smoking, unhealthy dietary habits and inadequately controlled arterial hypertension has contributed to premature mortality from NCDs, including diabetes and cancer [61,62].

Cardiovascular disease is still the leading cause of mortality among NCDs in many low- and middle-income countries [34,63,64], including post-Soviet nations due to inadequate implementation of existing prevention and treatment approaches [64]. Ischemic heart disease (IHD) has ranked as the leading cause of mortality among NCDs as shown by the data in Table 3, with large variations between different countries. In 2019, Belarus, Russia, and Armenia had the highest mortality rates from IHD, with rates of 574.88, 383.46 and 306.05 per 100,000 population, respectively. Contrastingly, Tajikistan and Kyrgyzstan had the lowest death rates with 142.35 and 175.70, respectively. In Kazakhstan, the deployment of government-funded intervention methods for the management of CVD has resulted in a significant decline in IHD-related mortality rates [65]. Certainly, it appears that national policymakers might consider prioritizing prevention strategies and potentially structuring health systems to address the challenges posed by the epidemic of CVD.

Cancer was the second leading cause of mortality among NCDs [23]. With improvement of nutrition, water, sanitation and hygiene, primary and secondary prevention for infectious diseases, and changing socio-demographics, cancer has become one of the leading causes of death [34]. Lung cancer mortality was the primary cause of cancer fatalities in the majority of former Soviet states due to a high prevalence of smoking and an industrialized economy with associated air pollution [66]. However, an upward trend in breast cancer incidence over the past decade indicates the need for preventive measures [67]. In countries with the lowest HCI, such as Kyrgyzstan, Tajikistan, and Uzbekistan, gastric cancer incidence and mortality have historically been high. This is likely due to a high infestation of *Helicobacter pylori* and the influence of other environmental factors [68]. Table 3 presents the leading causes of mortality from NCD per 100,000 population. Nonetheless, although the rates of premature mortality from the main NCDs (CVD, cancer, diabetes, and chronic respiratory disease) were elevated, they exhibited a declining trend at least through 2019 as seen in Fig. 5. This phenomenon may be because all post-Soviet states have improved income, lifestyle, living conditions, and healthcare during the twenty-first century. In addition, recognizing that NCDs pose a significant public health challenge, the governments of all nations adopted national strategies for NCD prevention and control [69].

3.5. The burden of communicable disease

Following the dissolution of the USSR, the governments of the former Soviet republics made efforts to expand access to essential services for CDs, including prevention and treatment [23]. There has been a focus on tuberculosis (TB) and HIV/AIDS, with the support of international agencies such as the WB, WHO, the Global Fund to Fight AIDS, Tuberculosis and Malaria (GF ATM), as well as bilateral donors. International donors have played a substantial role in financing healthcare expenditures in certain nations, such as Tajikistan, Armenia, and Kyrgyzstan. Conversely, in other countries, the MoHs has collaborated with specialized agencies of the UN on initiatives
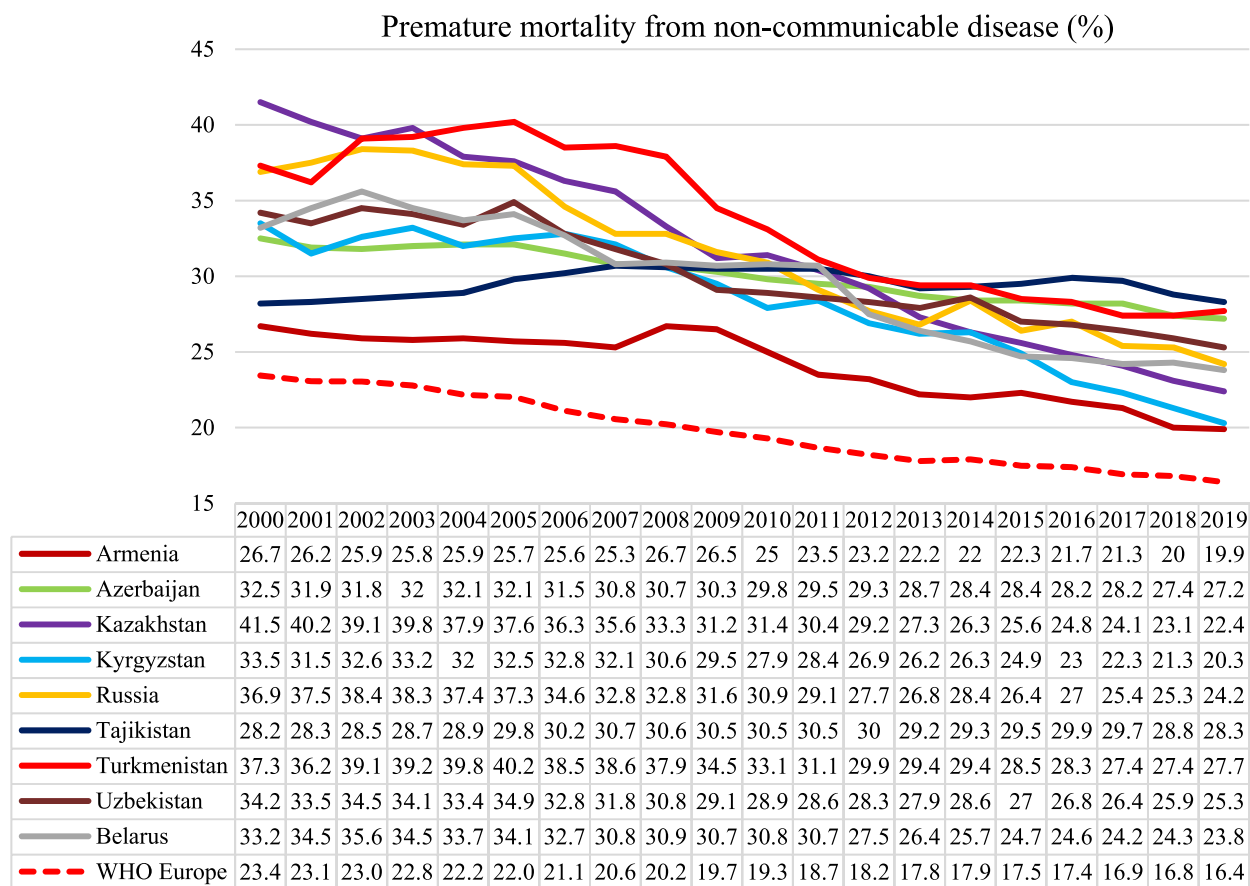
Premature mortality from non-communicable disease (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Armenia	26.7	26.2	25.9	25.8	25.9	25.7	25.6	25.3	26.7	26.5	25	23.5	23.2	22.2	22	22.3	21.7	21.3	20	19.9
Azerbaijan	32.5	31.9	31.8	32	32.1	32.1	31.5	30.8	30.7	30.3	29.8	29.5	29.3	28.7	28.4	28.4	28.2	28.2	27.4	27.2
Kazakhstan	41.5	40.2	39.1	39.8	37.9	37.6	36.3	35.6	33.3	31.2	31.4	30.4	29.2	27.3	26.3	25.6	24.8	24.1	23.1	22.4
Kyrgyzstan	33.5	31.5	32.6	33.2	32	32.5	32.8	32.1	30.6	29.5	27.9	28.4	26.9	26.2	26.3	24.9	23	22.3	21.3	20.3
Russia	36.9	37.5	38.4	38.3	37.4	37.3	34.6	32.8	32.8	31.6	30.9	29.1	27.7	26.8	28.4	26.4	27	25.4	25.3	24.2
Tajikistan	28.2	28.3	28.5	28.7	28.9	29.8	30.2	30.7	30.6	30.5	30.5	30.5	30	29.2	29.3	29.5	29.9	29.7	28.8	28.3
Turkmenistan	37.3	36.2	39.1	39.2	39.8	40.2	38.5	38.6	37.9	34.5	33.1	31.1	29.9	29.4	29.4	28.5	28.3	27.4	27.4	27.7
Uzbekistan	34.2	33.5	34.5	34.1	33.4	34.9	32.8	31.8	30.8	29.1	28.9	28.6	28.3	27.9	28.6	27	26.8	26.4	25.9	25.3
Belarus	33.2	34.5	35.6	34.5	33.7	34.1	32.7	30.8	30.9	30.7	30.8	30.7	27.5	26.4	25.7	24.7	24.6	24.2	24.3	23.8
WHO Europe	23.4	23.1	23.0	22.8	22.2	22.0	21.1	20.6	20.2	19.7	19.3	18.7	18.2	17.8	17.9	17.5	17.4	16.9	16.8	16.4

Fig. 5. Mortality from cardiovascular disease, cancer, diabetes or chronic respiratory disease between ages 30 and 70 years (%), 2000–2019. Charting was performed by creating a custom chart based on the data obtained from the World Bank [18].

targeting certain diseases [23]. Historically, the countries of the former Soviet Union had good infection control services, including disease surveillance [70]. Nevertheless, infection prevention and control significantly deteriorated during the 1990s, and new challenges, such as HIV/AIDS and multidrug-resistant tuberculosis (MDR-TB) emerged.

Tuberculosis incidence and associated mortality rose during the 1990s but began to decline unevenly in the second half of the 2000s [33]. By 2019, most countries achieved a substantial reduction in TB mortality, except for Russia, which did not reach the 1990 level (Fig. 6). TB incidence and mortality peaked in Russia in the first half of the 2000s due to a variety of reasons, including protracted effects of socioeconomic crisis, high rates of alcohol consumption and incarceration, and a growing burden of HIV/AIDS [69]. From the beginning of the 2010 till 2020, there was a gradual decline of around 10 % in the annual mortality rate of TB. However, this positive trend was reversed due to the impact of the COVID-19 pandemic [71]. Some of the former Soviet republics have one of the highest rates of MDR-TB and extensively drug-resistant TB ever observed worldwide. This might be explained by the circulation of MDR-TB strains that seem to originate from an intricate transmission network existing in the territory of post-Soviet states [72]. There existed notable disparities in the overall TB treatment success rates across different nations. Specifically, Belarus, Armenia, and Uzbekistan exhibited the highest rates of treatment success, whilst Russia demonstrated the lowest rate of success. In the year 2021, the success rates for tuberculosis treatment were recorded at 92 % for Tajikistan, 88 % for Armenia, 84 % for Belarus, and a comparatively lower rate of 60 % for Russia (Fig. 7).

HIV/AIDS is another important issue in the area. During the 1990s and 2000s, former Soviet states suffered from the world's fastest-growing HIV epidemics, with the great majority of recorded infections being linked to injection drug use. Unfortunately, the majority of regional administrations had taken a while to appropriately address the issue. The size and scope of anti-HIV programs was insufficient, especially in regard to the availability of substitute treatments and the application of harm reduction strategies [23]. Such regional harm reduction programs heavily relied on outside funding, while buprenorphine or methadone substitution therapy was illegal in Russia and Turkmenistan [73]. In addition, a punitive approach to injection drug use was prevalent and was considered to be one of the main obstacles to expanding access to HIV prevention and treatment in the former Soviet Union [23].

Over the past decade, the proportion of HIV-positive people who were diagnosed, received treatment, and achieved a suppressed viral load increased as a result of improvements in HIV services provided at the level of primary care. Overall, the nations had been consistently increasing access to preventive and curative services, such as testing and counseling, informational and educational work,
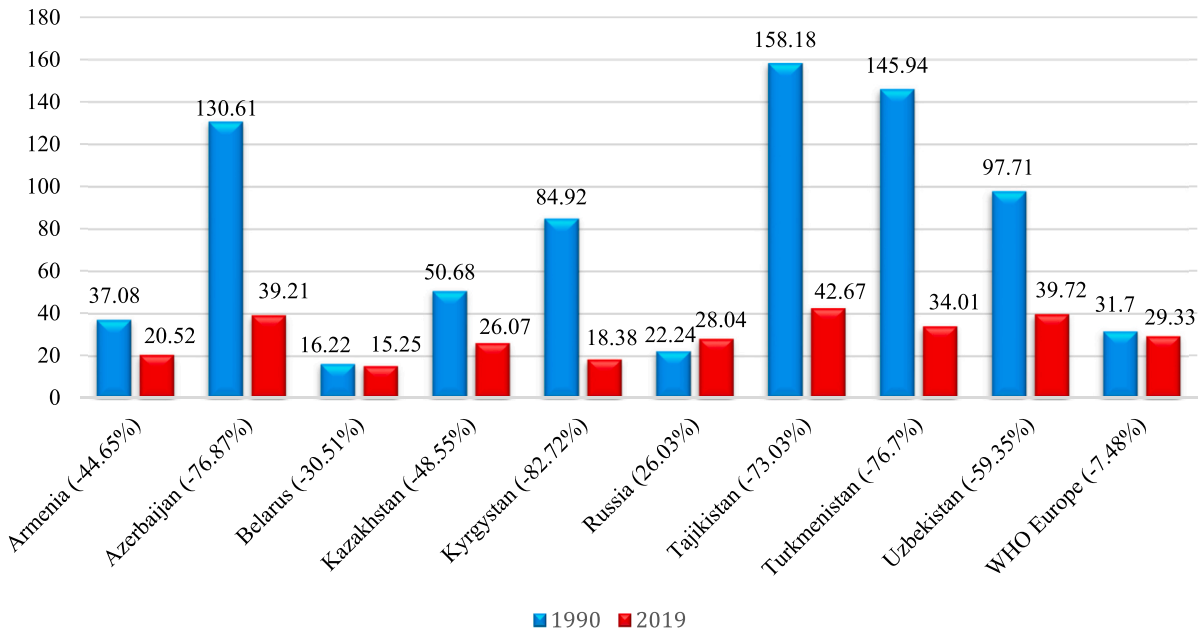
Mortality from respiratory infections and tuberculosis

Fig. 6. Mortality from respiratory infections and tuberculosis (all ages, both sexes) per 100, 000 population in 1990 and 2019 (with average change per annum, %) Charting was performed by creating a custom chart based on the data obtained from the IHME [62].
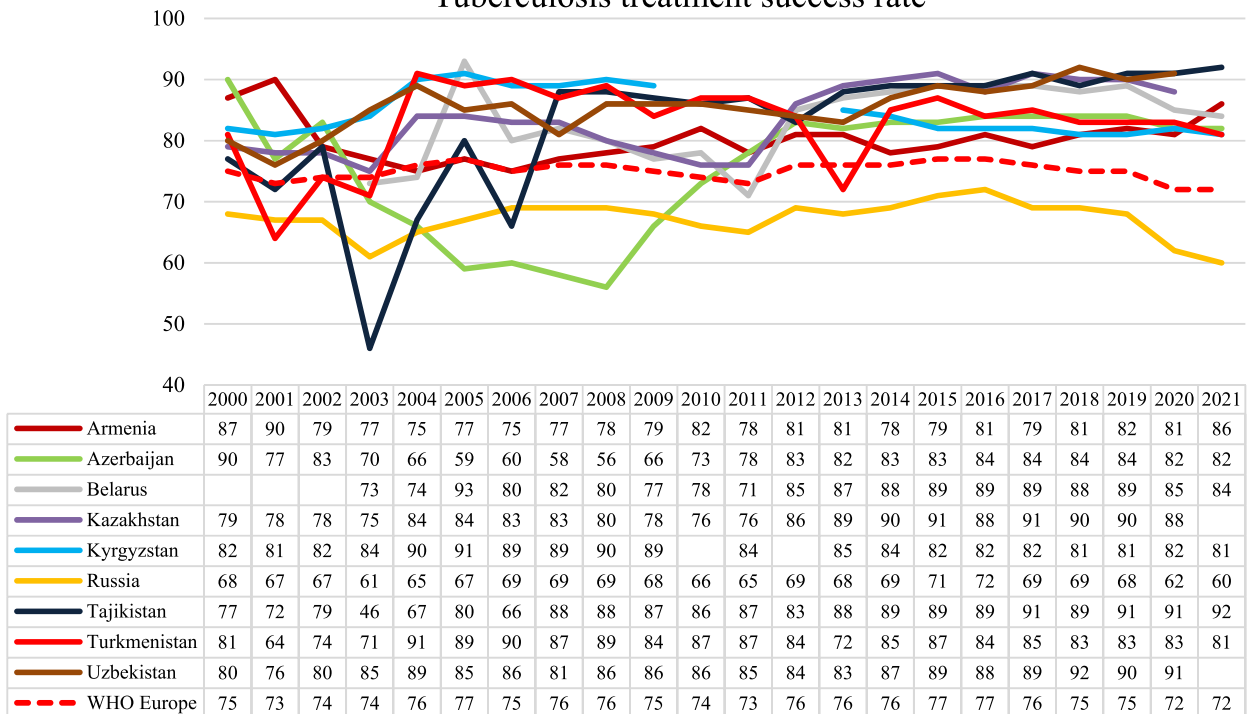
Tuberculosis treatment success rate

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Armenia	87	90	79	77	75	77	75	77	78	79	82	78	81	81	78	79	81	79	81	82	81	86
Azerbaijan	90	77	83	70	66	59	60	58	56	66	73	78	83	82	83	83	84	84	84	84	82	82
Belarus				73	74	93	80	82	80	77	78	71	85	87	88	89	89	89	88	89	85	84
Kazakhstan	79	78	78	75	84	84	83	83	80	78	76	76	86	89	90	91	88	91	90	90	88	
Kyrgyzstan	82	81	82	84	90	91	89	89	90	89		84		85	84	82	82	82	81	81	82	81
Russia	68	67	67	61	65	67	69	69	69	68	66	65	69	68	69	71	72	69	69	68	62	60
Tajikistan	77	72	79	46	67	80	66	88	88	87	86	87	83	88	89	89	89	91	89	91	91	92
Turkmenistan	81	64	74	71	91	89	90	87	89	84	87	87	84	72	85	87	84	85	83	83	83	81
Uzbekistan	80	76	80	85	89	85	86	81	86	86	86	85	84	83	87	89	88	89	92	90	91	
WHO Europe	75	73	74	74	76	77	75	76	76	75	74	73	76	76	76	77	77	76	75	75	72	72

Fig. 7. Tuberculosis treatment success rate (% of new cases), 2000–2021. The data for Kyrgyzstan for 2010 and 2012, and for Belarus for 2000–2002 are not available. Charting was performed by creating a custom chart based on the data obtained from the World Bank [18].

provision of free condoms, needles and syringes, quick testing, and prevention of mother-to-child HIV transmission [74]. Nonetheless, significant barriers were identified, including stigma against patients and a lack of motivation among medical professionals [75].

In 2021, the General Assembly of the United Nations issued a Political Declaration on HIV/AIDS that established objectives for reducing the HIV/AIDS burden. According to UNAIDS, by 2025, 95 % of people living with HIV should be aware of their status, at least 95 % of HIV-positive individuals should receive treatment, and 95 % of those receiving treatment should achieve viral load suppression [76,77]. The nations under consideration came closest to meeting the UNAIDS objective for notifying HIV-positive persons of their status in 2022, but the percentage of suppressed viral loads remained low. Azerbaijan had the highest HIV-positive status disclosure rate (81 %), followed by Kazakhstan (80 %), Belarus (79 %), and Kyrgyzstan (78 %). Belarus has the greatest HIV ART (antiretroviral therapy) coverage (79 %), followed by Uzbekistan (77 %), and Kazakhstan (64 %). Uzbekistan came closest to the UNAIDS objective for HIV viral load reduction (88 %), followed by Belarus (73 %), and Azerbaijan (58 %) (Fig. 8).

3.6. Maternal and child health

In the USSR, pregnant women and children received government-funded medical treatment [28]. Similarly, all post-Soviet nations established mother-child health policies even after the USSR collapsed [24]. This resulted in a decrease in mortality rates among mothers, infants, and children under the age of five.

Reducing **maternal mortality** was one of the foremost priorities for national healthcare systems. The least significant reduction in maternal mortality occurred in Kyrgyzstan (1.51 % (95 % CI: −2.14 to −0.88 %)) and Uzbekistan (2.24 %). Kyrgyzstan has the highest maternal death rate in WHO Europe, highlighting perinatal care issues [78]. These primary causes of maternal mortality, such as obstetric hemorrhages, hypertension, septic conditions, and preterm birth complications, should not result in mortality in hospitals with high performance. In addition, the 2018 Multiple Indicator Cluster Survey revealed that 77 % of Kyrgyz women were oblivious of extant social benefits and lacked the knowledge to register for them [46]. Two countries (Belarus and Turkmenistan) had lower maternal mortality rates than the European region average (Fig. 9a). This indicates strong maternity care in Belarus and raises concerns about Turkmenistan's inadequate health data and statistics [27].

Childhood mortality: National governments also prioritized the reduction of childhood mortality. Before Turkmenistan started to show the highest rates of newborn and child under-five mortality in the early 2010s, Tajikistan had the highest rates of any of the nations included in this review. Elevated rates of child deaths were caused by a number of causes, including inadequate emergency treatment and reluctance to seek medical attention because of the high OOP expenses [38]. Despite inadequate data, Belarus and Russia had among the lowest baby and child under-five death rates, which closely matched the WHO European region's findings. This suggests that child care systems are doing well (Fig. 9b and c). While the health statistics pertaining to the nations that constituted the former USSR were generally comprehensive and trustworthy, it is probable that the official data presented a tendency to underestimate the true figures [23]. According to a research conducted in Azerbaijan, there was a notable improvement of almost 18 % in the likelihood of infant survival when mothers were given the opportunity to deliver their babies in a healthcare facility [79]. Sick
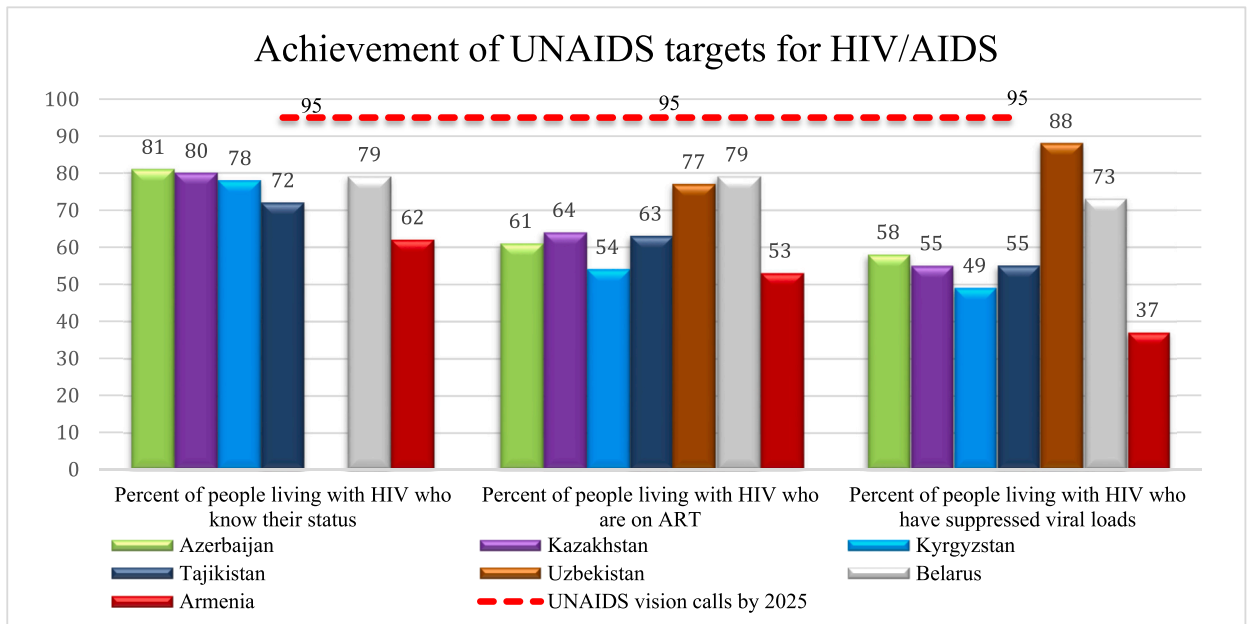
Fig. 8. Achievement of UNAIDS targets for HIV/AIDS by 2022 (%). Notes: ART – antiretroviral therapy; UNAIDS – The Joint United Nations Program on HIV/AIDS; the data for Russia and Turkmenistan are not available, the data for Uzbekistan on percent of people living with HIV who know their status are not available Charting was performed by creating a custom chart based on the data obtained from the UNAIDS [76,77].
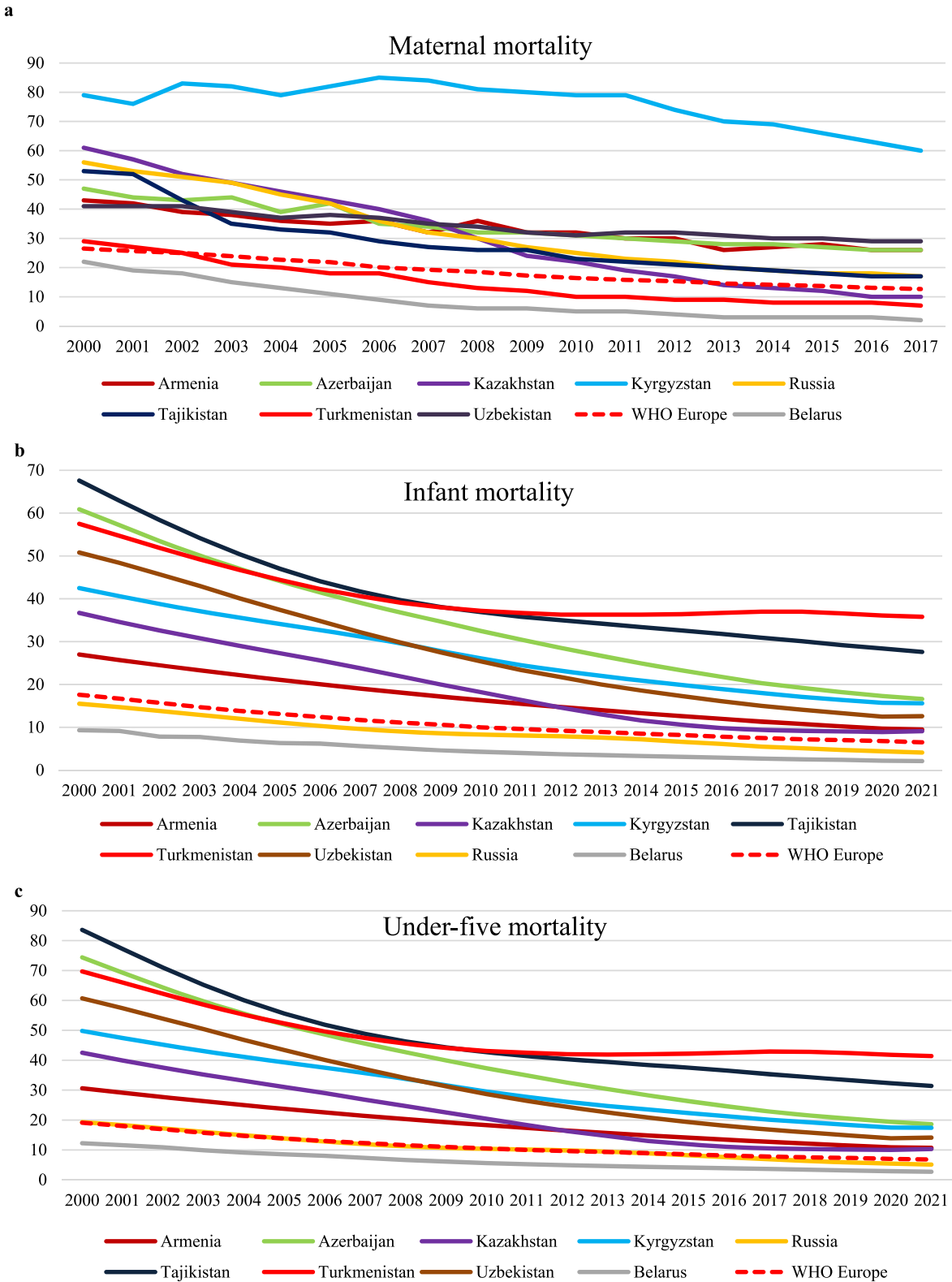
Fig. 9. The rates of maternal mortality per 100,000 live births, 2000–2017 **(a)**, infant **(b)** and under-five mortality per 1000 live births, 2000–2021 **(c)**. Charting was performed by creating a custom chart based on the data obtained from the World Bank [18].

neonates' transportation was another issue. Due to their limited populations, most post-Soviet republics have poor road infrastructure and surface conditions [80]. In addition, treatment for common childhood illnesses was substandard. In the early phases of prenatal care, excessive treatment and needless hospitalization were common [23].

Reproductive health and family planning services exhibit significant disparities among the countries within the region. Significant gaps still persisted despite the high emphasis given to mother and child health, such as the absence of counseling on contraception, adolescent-friendly sexual services, and reproductive healthcare [81]. In the early phases of transition, countries that emerged from the Soviet Union accepted contraception more. However, donor funding declined, slowing growth in this area, and sex education in the late 1980s followed similar trends. Many countries' educational systems were unprepared for this transformation, and even sex education in school curriculum was excluded from Russian schools [82]. Abortions peaked in the mid-1960s in the USSR, with 3 abortions per live birth, and began to fall in 1988. Russia contributed considerably to abortions in the former USSR, but from 1988 to 2015, abortions dropped 5.5 times. This drop was especially evident in younger populations, and several EU nations had higher teenage abortion rates by 2019 [83]. While other nations in this research lacked reliable statistics, Armenia and Azerbaijan had higher abortion rates than Russia [84].

Childhood immunization: During the Soviet period, routine childhood immunization programs achieved high coverage [23]. These vaccinations were provided free of charge to newborns in maternity hospitals and basic healthcare facilities. Following the dissolution of the USSR, each country established a universal immunization program covering TB, diphtheria, tetanus, pertussis, polio, Haemophilus influenzae type b (Hib), hepatitis B, measles, mumps, and rubella. With the exception of Russia, all countries included pneumococcal vaccination in their programs. Additionally, Kyrgyzstan, Tajikistan, Uzbekistan, Turkmenistan, and Armenia administered rotavirus vaccines to their pediatric population. Armenia was the sole country to provide immunization against meningococcal disease and tularemia [85]. Azerbaijan also offered vitamin A supplements during immunizations. Human papillomavirus (HPV) vaccines were administered in Turkmenistan, Kyrgyzstan, and Uzbekistan [86,87], while Kazakhstan attempted to introduce HPV immunization unsuccessfully.

Overall, nurses' authority in delivering vaccines was limited, requiring a doctor's approval [88]. Vaccine hesitation, the unwillingness to be vaccinated despite its availability, is becoming a global concern [82,83], and former Soviet states have some of the

Proportion of mental illnesses as a share of total disease burden

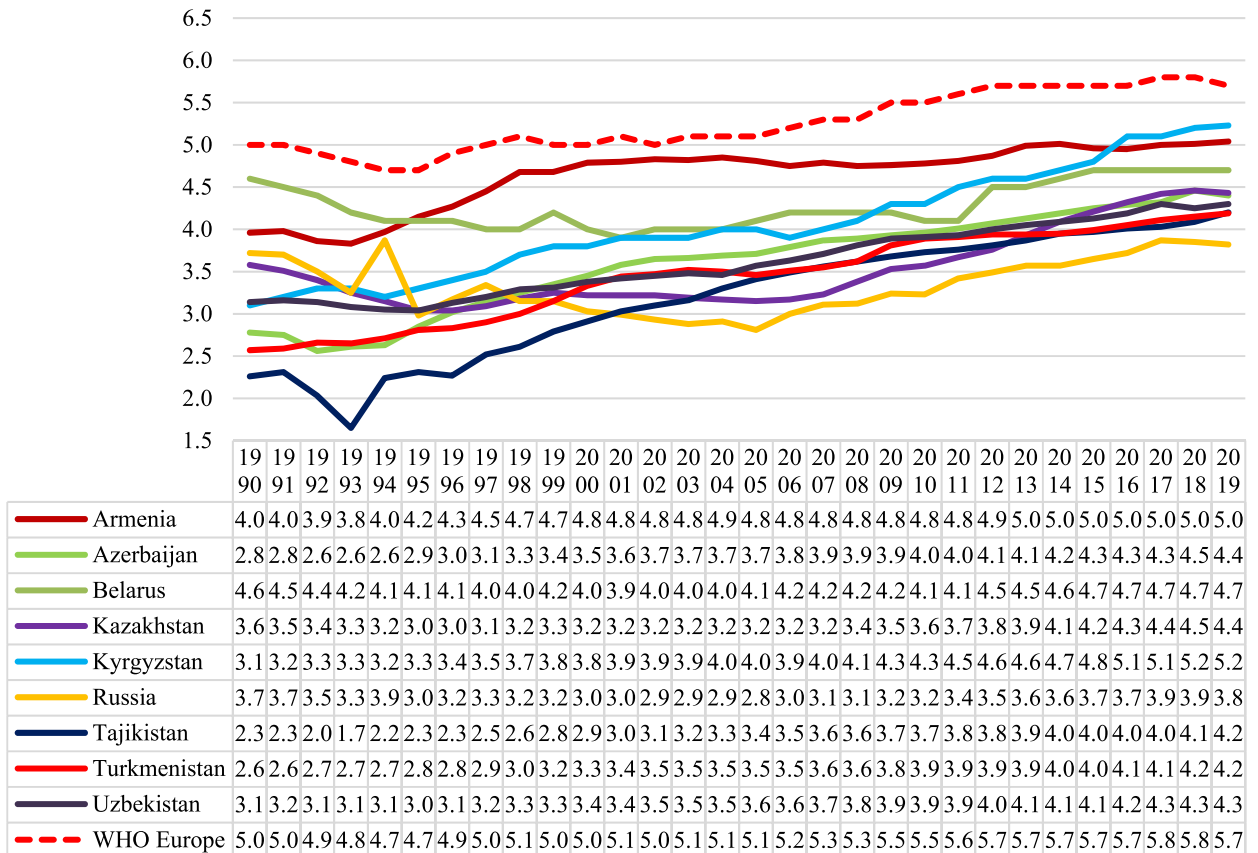|	19 90	19 91	19 92	19 93	19 94	19 95	19 96	19 97	19 98	19 99	20 00	20 01	20 02	20 03	20 04	20 05	20 06	20 07	20 08	20 09	20 10	20 11	20 12	20 13	20 14	20 15	20 16	20 17	20 18	20 19
Armenia	4.0	4.0	3.9	3.8	4.0	4.2	4.3	4.5	4.7	4.7	4.8	4.8	4.8	4.8	4.9	4.8	4.8	4.8	4.8	4.8	4.8	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Azerbaijan	2.8	2.8	2.6	2.6	2.6	2.9	3.0	3.1	3.3	3.4	3.5	3.6	3.7	3.7	3.7	3.8	3.9	3.9	3.9	4.0	4.0	4.1	4.1	4.2	4.3	4.3	4.3	4.3	4.5	4.4
Belarus	4.6	4.5	4.4	4.2	4.1	4.1	4.1	4.0	4.0	4.2	4.0	3.9	4.0	4.0	4.0	4.1	4.2	4.2	4.2	4.2	4.1	4.1	4.5	4.5	4.6	4.7	4.7	4.7	4.7	4.7
Kazakhstan	3.6	3.5	3.4	3.3	3.2	3.0	3.0	3.1	3.2	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.1	4.2	4.3	4.4	4.5	4.4
Kyrgyzstan	3.1	3.2	3.3	3.3	3.2	3.3	3.4	3.5	3.7	3.8	3.8	3.9	3.9	3.9	4.0	4.0	3.9	4.0	4.1	4.3	4.3	4.5	4.6	4.7	4.8	5.1	5.1	5.2	5.2
Russia	3.7	3.7	3.5	3.3	3.9	3.0	3.2	3.3	3.2	3.2	3.0	3.0	2.9	2.9	2.9	2.8	3.0	3.1	3.1	3.2	3.2	3.4	3.5	3.6	3.6	3.7	3.7	3.9	3.9	3.8
Tajikistan	2.3	2.3	2.0	1.7	2.2	2.3	2.3	2.5	2.6	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.6	3.7	3.7	3.8	3.8	3.9	4.0	4.0	4.0	4.0	4.1	4.2
Turkmenistan	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.9	3.0	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.6	3.6	3.8	3.9	3.9	3.9	3.9	4.0	4.0	4.1	4.1	4.2	4.2
Uzbekistan	3.1	3.2	3.1	3.1	3.1	3.0	3.1	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.5	3.6	3.6	3.7	3.8	3.9	3.9	3.9	4.0	4.1	4.1	4.2	4.3	4.3	4.3
WHO Europe	5.0	5.0	4.9	4.8	4.7	4.7	4.9	5.0	5.1	5.0	5.0	5.1	5.0	5.1	5.1	5.1	5.2	5.3	5.3	5.5	5.5	5.6	5.7	5.7	5.7	5.7	5.8	5.8	5.7

Fig. 10. The proportion of mental illnesses as a share of total disease burden in the post-Soviet countries between 1990 and 2019 (%) Charting was performed by creating a custom chart based on the data obtained from the Our World in Data [99].

greatest vaccine skepticism [89]. Before the COVID-19 pandemic, 25 % of these nations' populations opposed vaccination, twice as high as in the United States [89]. Thus, certain countries in the region have vaccine-preventable diseases. Multiple measles outbreaks have occurred in the previous 20 years, and a 1990s diphtheria pandemic was widespread [90,91]. High vaccine rejection rates contributed to Kazakhstan's 2013 pilot HPV immunization program's failure [92]. Mistrust of the government, which was often tied to state-provided healthcare, difficulties analyzing information sources, and a lack of personal connections to experienced healthcare experts may explain vaccination hesitation [89].

3.7. Mental health

As defined by the WHO (2022), mental health is *"a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community"* [93]. From childhood and youth to adulthood and aging, mental health is crucial at every stage of one's life [94]. Despite the importance of the state of mental health, there is still a substantial underreporting of mental health issues around the world, especially in the former Soviet Union nations where mental illness was connected to stigmatizing attitudes, discriminatory practices, and Soviet era abuses and mistreatment [95,96]. Unlike many other European nations, the post-Soviet countries lacked a history of conducting population-wide surveys on mental health using internationally standardized instruments or WHO-accepted definitions and diagnostic tools [93]. Thus, these countries can be described as a "blind spot" in terms of mental health [97].

The prevalence of mental disorders: In 2012, 335.6 per 100,000 Russians had mental and behavioral issues, according to statistics, while the incidence was low at 49.2 per 100,000 in Kyrgyzstan [98]. The incidence rate suggests that Russia detected more mental diseases than Kyrgyzstan [98]. Between 1990 and 2019, the Global Burden of Disease Collaborative Network (2019) found that mental illnesses as a percentage of the disease burden increased in Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, and Uzbekistan (Fig. 10). Kyrgyzstan had the most mental diseases in 2019 at 5.23 %, followed by Armenia at 5.04 %. Mental illness frequency in Azerbaijan has doubled from 2.78 % to 4.4 % in 29 years [98]. Nevertheless, the prevalence of mental disorders as a proportion of total disease burden in post-Soviet countries remained below the WHO Europe average, indicating that cases are possibly under-identified.

Depression and anxiety disorders were stable across most countries from 1990 to 2020, indicating a low incidence of detection and diagnosis. In Azerbaijan, depression prevalence stayed at 2.8 % from 1990 to 2020. During the same time, 2.5 % had anxiety. Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, and Uzbekistan have seen a slight decline in depression. This data shows that Armenia and Belarus alone saw an increase in depression rates (Table 4). In contrast, the prevalence of depression and anxiety among individuals residing in the EU was somewhat higher when compared to the nations examined in this analysis. Specifically, the rates of depression and anxiety in the EU were recorded at 3.6 % and 5.2 % respectively in the year 2019 (Table 4). In absolute terms, the number of people with depression in both 1990 and 2019 was much higher in Russia compared with other former USSR states, with about 5,401,788 and 5,453,827 cases, respectively [99,100]. By contrast, the lowest numbers were reported in Armenia at the beginning of the 1990s, approximately 91,333 cases, with the following dramatic rise of 105,444 cases in 2019 [101]. If left unmanaged, depression can result in suicide, accounting for more than 700,000 deaths every year globally [101] and studies indicate that depressed individuals have higher mortality rates [99,102].

Mental health budget allocation was just 3 % of post-Soviet states' health expenditures, despite the high sickness burden. This is below Europe's median of 5 % [96]. Statistical data shows that mental healthcare accessibility decreased immediately after the Soviet Union collapsed [97]. Most treatment was provided in large mental facilities due to a lack of beds in hospitals and community care [96]. Most of these institutions had unreasonable expectations, lacked privacy, and needed repair and restoration. In general, these establishments were burdened with excessive demands, lacked adequate privacy provisions, and required maintenance and restoration efforts. A scarcity of psychiatrists, social workers, and psychologists was seen in all nations within the post-Soviet zone 96,97]. Furthermore, the field of mental health treatment encountered significant information gaps, with little epidemiological research and a lack of thorough policy or economic analysis [102]. The available evidence implies that there was a lack of sufficient attention given to the issue of mental health.

Table 4
The proportion of population with depressive and anxiety disorders (all ages, both sexes) in 1990 and 2019.

Country	Depressive disorders		Anxiety disorders	
	1990	2019	1990	2019
Armenia	2.8 %	3.0 %	3.1 %	3.2 %
Azerbaijan	2.8 %	2.8 %	2.5 %	2.5 %
Belarus	3.3 %	3.8 %	3.5 %	3.5 %
Kazakhstan	3.5 %	3.4 %	2.1 %	2.1 %
Kyrgyzstan	3.7 %	3.4 %	2.1 %	2.1 %
Russia	3.2 %	3.1 %	3.2 %	3.1 %
Tajikistan	3.0 %	2.8 %	2.4 %	2.4 %
Turkmenistan	3.2 %	3.1 %	2.3 %	2.3 %
Uzbekistan	3.3 %	3.2 %	2.0 %	2.0 %
European Union	3.7 %	3.6 %	5.0 %	5.2 %

The data for the table were obtained from the Our World in Data [99].

3.8. Challenges of the COVID-19 epoch

The COVID-19 pandemic had devastating impacts on public health, leading to the inaccessibility of health services for many people in need, catastrophic healthcare expenditures, and premature deaths. In the countries reviewed, the first cases of COVID-19 were registered in February–March 2020, and strict lockdowns were imposed shortly afterwards [97] In a later public discussion, such measures were considered premature and even harmful, as they resulted in decreased threat awareness and rapid epidemic expansion shortly after lockdowns were removed [103]. The countries experienced a shortage of facilities and medical professionals, which was particularly profound due to an earlier reduction in the number of hospital beds. The more affluent countries within the region, Russia, Kazakhstan, and Azerbaijan allocated substantial financial resources towards the containment of the epidemic. But these resources proved to be insufficient due to a severe shortage of essentials like medicines, diagnostic tests, and personal protective equipment, particularly during the peak period [104].

Excess mortality, defined as an increased death rate from all causes compared to projections, reached its peak in many countries of the region during 2020. Another peak was observed in the fall of 2021, likely reflecting the spread of the Delta variant [29]. Subsequently, there were no abrupt increases in excess mortality rates, although no country had returned to baseline levels by early May 2023, when the WHO officially declared the end of the COVID-19 pandemic (Fig. 11) [30].Overall, the COVID-19 pandemic has brought to light a notable reluctance on the part of local administrations to accurately ascertain the true extent of cases and fatalities [31]. Hence, a notable disparity existed between the mortality figures officially recorded and the extra mortality, indicating potential manipulation of data. Based on these research findings, Belarus, Tajikistan, Russia, and Uzbekistan were identified as countries that exhibited a higher degree of unreliable health statistics in their health data compared to other nations [31].

Low rates of **COVID-19 immunization** have significant ramifications and have a large role in the return of infections and the resulting high number of fatalities [36]. In the former USSR, the populace's reluctance to undergo vaccination emerged within the framework of strained relations between the citizenry and the state, and was not only rooted in a general skepticism towards medical research [37]. Postponed immunization, alternate vaccination schedules, and preference for a particular vaccine brand at a certain healthcare facility reflect vaccine hesitation [106]. The current scenario presents a significant issue in terms of public health, necessitating substantial efforts to be undertaken in order to alter the perspectives of the general population [70]. Fig. 12 illustrates the rates of COVID-19 vaccination in the former USSR states in comparison with the data from the EU. As the data demonstrate, the share of people with a complete initial protocol in the countries of the EU was higher than in the countries under review (72.86 %). Only Belarus reached comparable rates, with 66.65 % of people completing the initial protocol.

4. Discussion

This scoping review aimed to delineate the historical evolution of healthcare systems in Kazakhstan, Kyrgyzstan, Uzbekistan,

Excess mortality in 2020-2023

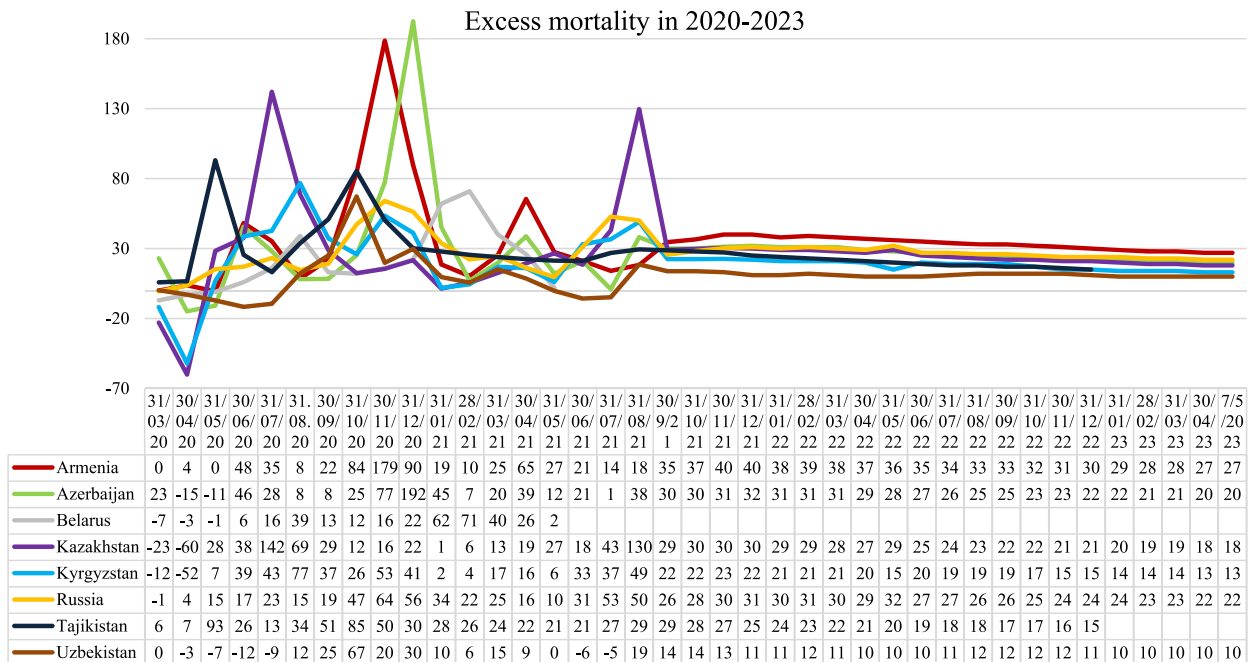| Country	31/03/20	30/04/20	31/05/20	30/06/20	31/07/20	31.08.20	30/09/20	31/10/20	30/11/20	31/12/20	31/01/21	28/02/21	31/03/21	30/04/21	31/05/21	30/06/21	31/07/21	31/08/21	30/09/21	31/10/21	30/11/21	31/12/21	31/01/22	28/02/22	31/03/22	30/04/22	31/05/22	30/06/22	31/07/22	31/08/22	30/09/22	31/10/22	30/11/22	31/12/22	31/01/23	28/02/23	31/03/23	30/04/23	7/5/23
Armenia	0	4	0	48	35	8	22	84	179	90	19	10	25	65	27	21	14	18	35	37	40	40	38	39	38	37	36	35	34	33	33	32	31	30	29	28	28	27	27
Azerbaijan	23	-15	-11	46	28	8	8	25	77	192	45	7	20	39	12	21	1	38	30	30	31	32	31	31	31	29	28	27	26	25	25	23	23	22	22	21	21	20	20
Belarus	-7	-3	-1	6	16	39	13	12	16	22	62	71	40	26	2																								
Kazakhstan	-23	-60	28	38	142	69	29	12	16	22	1	6	13	19	27	18	43	130	29	30	30	30	29	29	28	27	29	25	24	23	22	22	21	21	20	19	19	18	18
Kyrgyzstan	-12	-52	7	39	43	77	37	26	53	41	2	4	17	16	6	33	37	49	22	22	23	22	21	21	20	15	20	19	19	19	17	15	15	14	14	14	13	13	
Russia	-1	4	15	17	23	15	19	47	64	56	34	22	25	16	10	31	53	50	26	28	30	31	30	31	30	29	32	27	27	26	26	25	24	24	24	23	23	22	22
Tajikistan	6	7	93	26	13	34	51	85	50	30	28	26	24	22	21	21	27	29	29	28	27	25	24	23	22	21	20	19	18	18	17	17	16	15					
Uzbekistan	0	-3	-7	-12	-9	12	25	67	20	30	10	6	15	9	0	-6	-5	19	14	14	13	11	11	12	11	10	10	10	11	12	12	12	12	11	10	10	10	10	10

Fig. 11. Excess mortality (deaths from all causes compared to projection) for the years 2020–2023 (%); data for Belarus as of June 30, 2021 and data for Tajikistan as of January 31, 2023, are not available. Charting was performed by creating a custom chart based on the data obtained from the Our World in Data [105].
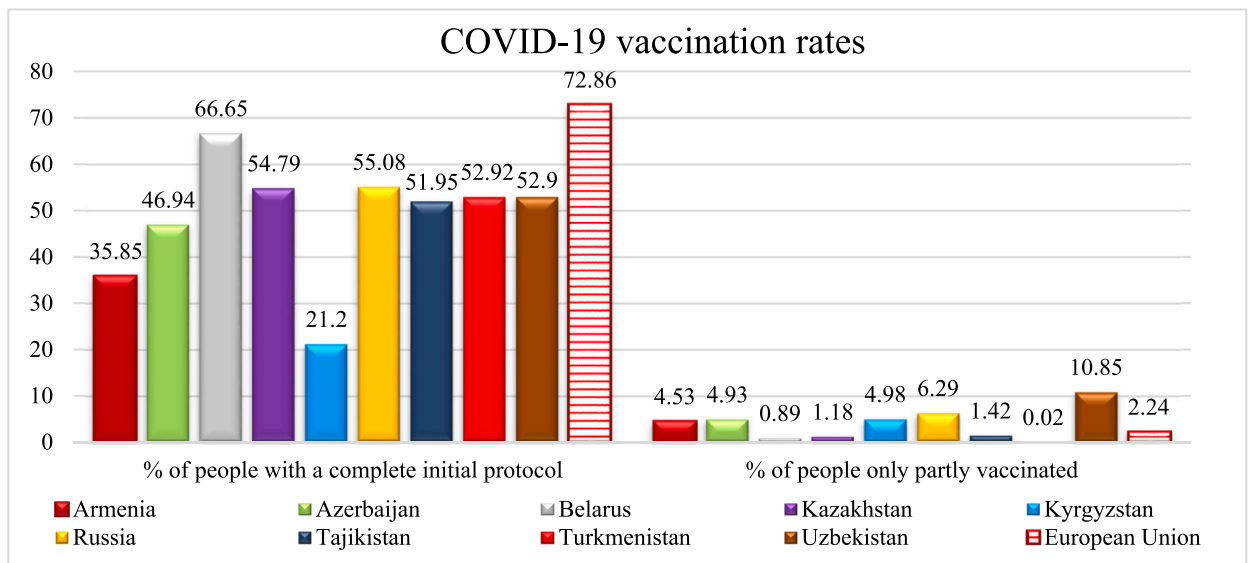
Fig. 12. COVID-19 vaccination: share of people with a complete initial protocol and share of people only partly vaccinated (%) Charting was performed by creating a custom chart based on the data obtained from the Our World in Data [105].

Tajikistan, Turkmenistan, Armenia, Azerbaijan, Belarus, and Russia from 1991 to the present. The findings facilitated the acquisition of vital insights into the resultant changes in the health status of the nations under examination, with a particular focus on NCDs, CDs, maternal and child health, and mental health. To the best of our knowledge, this represents the first scoping review providing a comparative analysis among the countries of the former USSR. These findings necessitate further discussion in relation to earlier literature on the topic.

4.1. Review of relevant literature on the topic

In their comparative study, McKee and his co-authors delineated the health sector reform in the former Soviet republics of Central Asia from the dissolution of the USSR to 1998. The authors extended their analysis to include Azerbaijan in their study, owing to cultural similarities and its participation in the Central Asian Republics Network on health sector reform. They underscored that while universal access to a basic level of care was provided to populations across all countries, primary care remained underdeveloped, and health promotion activities were scarce, predominantly focusing on educational approaches. Many facilities, particularly those situated in rural areas, lacked even basic amenities such as running water or sewerage systems. A substantial decline in life expectancy was noted following the dissolution of the USSR, attributed to a rapid increase in mortality among adults, particularly from CVDs, as well as accidents and violence. Additionally, the health status of women deteriorated, reversing the gains made during the Soviet era and resulting in the widespread prevalence of anemia and other chronic female health issues. The authors also highlighted that infant mortality rates were much higher than in Western Europe, largely due to a significant burden of diarrheal and respiratory infections [25].

Rechel and his colleagues conducted three studies evaluating health system reforms and the health status of the population in the former Soviet countries [23], the CIS [24], and Central Asia [27]. While two of the reports did not specify the period of coverage, the authors indicated that it spanned from the dissolution of the USSR to the following two decades [23,27], while the second report covered the period from 2005 to 2012 [24]. According to the authors, the governance of healthcare systems exhibited many similarities, with national MoHs playing a central role. Healthcare systems were structured into three administrative levels: national (republican), regional (oblast), and local (district or city). Each level was responsible for core functions including the pooling of health funds, procurement of services, and provision of care. Specialized health services, such as those for the management of sexually transmitted diseases, were provided through separate vertical systems, and numerous ministries, including the Ministry of Internal Affairs, the Ministry of Transport, the Ministry of Defence, and large enterprises, maintained their own parallel health systems [23,24]. The studies by Rechel and his colleagues corroborate the observation made by McKee and his co-authors regarding the dramatic decline in life expectancy, which was more pronounced in males and occurred shortly after the dissolution of the USSR. Throughout the period covered by the studies, the burden of premature mortality remained significantly higher than in EU countries. This was further exacerbated by high levels of inequality and a large proportion of OOP expenditure, exceeding 70 % in some countries such as Azerbaijan [27]. Communicable diseases were also a major concern, particularly HIV/AIDS and TB, with surveillance of infectious diseases deteriorating after the dissolution of the USSR [23,24,27]. All countries of Central Asia implemented healthcare reforms, which were often assisted by external agencies, such as the WHO, WB, USAID, DFID, or the Asian Development Bank. Kazakhstan was the only country that adopted a systematic approach after 2004. Reforms in Tajikistan were delayed due to the civil war, and in

Turkmenistan, they were halted due to the eccentric presidential rule [27].

The most recent review on the topic was conducted by Kühlbrandt and Boerma in 2015, focusing on the primary care reforms implemented in the former Soviet Union countries [9]. The authors underscored that despite many countries pledging to transition their centrally planned health systems into a 'family medicine model', significant heterogeneity exists among these nations. Most countries retained features of the Semashko model, with primary care primarily addressing a narrow range of conditions. Among all post-Soviet countries, Kyrgyzstan adopted a more comprehensive approach to family medicine reform. However, as of 2015, significant gaps in access to high-quality primary care persisted in many countries, attributed by the authors to several factors. These included inadequate financial support for primary care provision and incomplete and fragmented primary care reforms, despite the partial implementation of some aspects of family medicine. The authors highlighted that MoHs failed to provide effective support for primary care reform, stemming from a lack of political will, which hindered the implementation of more fundamental reforms. They concluded that achieving full implementation of the family medicine model required clearly defined levels of care and responsibilities [9].

The main finding of this scoping review is that while post-Soviet countries have made certain improvements in people's health. However, much more needs to be done to achieve Sustainable Development Goal 3 – good health and well-being.

4.2. Issues that need to be addressed to achieve the Sustainable Development Goal 3

The UN SDG 3 aims at ensuring healthy lives and promoting well-being for all at all ages [107]. As of the year 2022, all the post-Soviet countries covered in this analysis have successfully attained the SDG 3 Target 3.1 Indicator 3.1.1, which pertains to the maternal mortality ratio. Furthermore, most of these countries have nearly fulfilled the SDG 3 Target 3.1 Indicator 3.1.2, which concerns the proportion of births attended by qualified health staff, with the exception of Tajikistan. Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Russia, and Uzbekistan also have successfully attained SDG 3 Target 3.2, which pertains to the reduction of preventable newborn and child under-5 mortality. Nevertheless, both Russia and Turkmenistan were unable to attain the SDG 3 Target 3.3 Indicator 3.3.1, which measures the number of new HIV infections. Similarly, Azerbaijan, Kyrgyzstan, and Tajikistan have yet to accomplish the SDG 3 Target 3.7 Indicator 3.7.2, which pertains to the teenage birth rate. Not all countries were able to achieve the remaining Targets and Indicators of Goal 3. Specifically, there were significant challenges in meeting the SDG 3 Target 3.3 Indicator 3.3.2 (tuberculosis incidence), the SDG 3 Target 3.4 Indicator 3.4.1 (mortality caused by CVD, cancer, diabetes, or chronic respiratory disease), and the SDG 3 Target 3.6 Indicator 3.6.1 (road traffic mortality). Only Azerbaijan and Belarus were successful in achieving the SDG 3 Target 3.6 Indicator 3.6.1 road traffic mortality. Table 5 highlights the worrisome issues surrounding the provision of critical health services (SDG 3 Target 3.8 Indicator 3.8.1) and the death rates associated with home and ambient air pollution (SDG 3 Target 3.9 Indicator 3.9.1). The WHO has initiated the European Program of Work for the period of 2020–2025, titled United Action for Better Work [108] recognizing that nations cannot achieve prosperity if a significant portion of their population has inadequate health and well-being. The initiative is focused on eliminating the primary factors contributing to suboptimal health outcomes via the identification and remediation of key deficiencies within regional healthcare systems. In addition, the program aims to foster collaborative relationships that enable substantial improvements in healthcare delivery [109]. The anticipated outcome of program execution is the augmentation of political backing for healthcare initiatives and the facilitation of diverse financing alternatives [108].

4.3. Scoping review limitations

This scoping review has several limitations that need to be acknowledged. Primarily, it must be recognized that the countries covered by this review differ significantly in terms of their socioeconomic development, despite their shared historical past as socialist republics within the USSR and their current status as member countries of the range of international treaties. In fact, these countries exhibited variations even before the dissolution of the USSR, and their divergence has only widened since then. Due to substantial socioeconomic disparities, the limited comparability to EU countries further complicates the interpretation of the findings presented in this review. Another limitation is that the rapidly evolving nature of healthcare systems means that the findings of this review may be subject to changes and updates in the future. Hence, ongoing monitoring will be needed for a more comprehensive understanding of healthcare transformations in the post-Soviet CIS countries. Yet, examining the healthcare systems of these countries collectively provides valuable insights into the challenges and opportunities they face, enabling the understanding of common threads and trends.

5. Conclusions

The health status of individuals residing in the former USSR has seen notable improvements since the onset of the twenty-first century. This positive trend is reflected in the average life expectancy, which has witnessed a significant rise, ultimately surpassing the level observed in 1990 subsequent to the dissolution of the USSR. The rates of neonatal, child under five years, and maternal mortality substantially declined, as the overall mortality rate did. Nevertheless, in spite of these positive improvements, it is evident from statistics based on data from the WB and WHO that the health indicators of people in the post-Soviet countries were significantly lower than those of affluent OECD nations such Japan, South Korea, Germany, Australia, Norway, and others. After gaining independence, the majority of former Soviet nations undertook various modifications to their healthcare systems in response to political endeavors aimed at decentralizing governmental frameworks. Furthermore, the lack of adequate resource allocation with the decentralization of authority to local governments has hindered the effective control of the healthcare system, therefore affecting equity in health spending. Furthermore, the health information systems exhibited fragmentation and produced low-quality data,

Table 5
Achievement of selected indicators for Sustainable Development Goal 3: Ensure healthy lives and promote well-being for all at all ages..

Indicators	Armenia	Azerbaijan	Belarus	Kazakhstan	Kyrgyzstan	Russia	Tajikistan	Turkmenistan	Uzbekistan
Maternal mortality ratio (Indicator 3.1.1)	green	green	green	green	green	green	green	green	green
Proportion of births attended by skilled health personnel (Indicator 3.1.2)	green	green	green	green	green	green	yellow	green	green
Under-5 mortality rate (Indicator 3.2.1)	green	green	green	green	green	green	yellow	orange	green
Neonatal mortality rate (Indicator 3.2.2)	green	green	green	green	green	green	yellow	red	green
Number of new HIV infections (Indicator 3.3.1)	green	green	green	green	green	orange	orange	orange	green
Tuberculosis incidence (Indicator 3.3.2)	yellow	orange	yellow	orange	red	orange	red	orange	orange
Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease (Indicator 3.4.1)	yellow	red	orange	orange	orange	orange	orange	yellow	red
Death rate due to road traffic injuries (Indicator 3.6.1)	red	green	green	orange	orange	yellow	yellow	orange	yellow
Adolescent birth rate: aged 15–19 years (Indicator 3.7.2)	green	orange	green	orange	orange	green	red	green	green
Coverage of essential health services (Indicator 3.8.1)	orange	orange	yellow	yellow	yellow	yellow	yellow	orange	orange
Mortality rate attributed to household and ambient air pollution (Indicator 3.9.1)	yellow	yellow	yellow	yellow	yellow	orange	orange	orange	yellow

■ major challenges, ■ significant challenges, ■ challenges remain, ■ indicator achieved

impeding the ability to formulate evidence-based policies. In order to optimize the prospective efficacy of forthcoming healthcare reforms, it is essential for governmental entities to assume oversight of the reform process, assess the attainment of predetermined targets, and implement necessary modifications accordingly. The success of future changes will rely on the active involvement of the government, medical community, and patient community, as well as the endorsement of local health authorities.

Data availability

The data associated with this scoping review were not deposited into a publicly available repository because the review relies on open-source data. However, data collected for the purpose of this review will be made available upon request.

Ethics statement

Not applicable as this is a review article.

CRediT authorship contribution statement

Yuliya Semenova: Writing – original draft, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Lisa Lim:** Writing – review & editing, Validation, Supervision, Software, Project administration, Investigation. **Zhandos Salpynov:** Writing – review & editing, Visualization, Validation, Supervision, Software, Project administration. **Abduzhappar Gaipov:** Writing – review & editing, Validation, Software, Resources, Methodology. **Mihajlo Jakovljevic:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing

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Appendix A. Supplementary data

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