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Healthcare in Russia: Macroeconomic Parameters and Structural Issues

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Abstract—The epidemiological crisis of 2020–2021 has revealed a number of imbalances and "bottlenecks" that have developed in the Russian healthcare system over the past 20 years as a result of a policy of limiting development to breakthroughs in individual areas accompanied by optimization of the sector. It became evident that one of the most acute problems is interregional disparity in terms of personnel and resource availability in the healthcare system, which determines the system's ability to respond to challenges and shocks. Solving these problems requires a comprehensive approach: simply increasing the sector's financing is not sufficient and must be accompanied by structural changes, in particular, modifying the education system and training new highly qualified personnel, creating an effective system of territorial distribution of personnel, and radically increasing the availability of high-end equipment, i.e., a transition to a new model of healthcare.

Keywords: healthcare, mortality rate, life expectancy, regions, human capital, new model of healthcare, development scenarios

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Russian healthcare in the face of the 2020–2021 pandemic. The epidemiological crisis of 2020–2021 proved to be a challenge for healthcare systems globally. Meanwhile, the Russian healthcare system has for the past several years been underfinanced in comparison to OECD countries and especially to advanced economies, which many experts have indicated as one of the reasons for the country's underperformance in terms of qualitative indicators of public health: mortality rate, life expectancy, morbidity, etc. [1]. However, the pandemic has shown that the state of a country's healthcare system and its ability to respond to crises and shocks are not exclusively determined by the volume of allocated financial resources, but also affected by the level of availability of highly qualified personnel, high-end equipment, medicine, and a developed research base [2]. Even in advanced economies with high shares of public spending on healthcare in GDP, the 2020 mortality rate from COVID-19 was significant and exceeded the corresponding values for Russia (Table 1).

However, by 2021 most advanced countries managed to mobilize their resources and achieve a downward trend in mortality from COVID-19 [3]. Up until the end of 2021, despite the emergence of new strains, many states demonstrated a gradual decrease in the mortality rate from COVID-19 despite the steadily increasing number of people infected. In 2020 some countries even managed to avoid a sharp decline in the qualitative public health indicator of life expectancy: in Israel it decreased by only 0.1 year, in Germany by 0.3 years [4]. Healthcare expenditures in advanced countries in 2021 remained at the high level of 2020.

In Russia, on the contrary, the mortality rate had significantly increased despite the growing share of vaccinated population [5]. The peak numbers of deaths from the coronavirus infection were observed in October–November 2021; by the end of December, the mortality rate, according to the Operational Headquarters, exceeded the 2020 value 1.6-fold. By the end of 2021 Russia's values of this indicator were higher than in most advanced countries, while healthcare spending decreased to 6.3% of GDP compared to 7.1% of GDP in 2020.

The causes of the high mortality rate from COVID-19 and the increased mortality rate from all causes require special research. While they are partially associated with the overloaded state of the healthcare system and its unpreparedness for the second COVID wave, there were additional long-term factors and imbalances in the development of Russian healthcare and public health in general that also contributed to the increased mortality rate of 2021.

As the Chinese saying goes, "who controls the past controls the future." The key directions of healthcare development were set in strategic documents: the

Table 1. Comparison of COVID-19 morbidity and mortality rates and healthcare financing in Russia and other countries

Indicator	Russia	Poland	France	Germany	Italy	Israel	USA
Healthcare spending, % of GDP $\left(\frac{2019}{2020}\right)$	5.8 7.1	6.4 6.5	11.1 12.2	11.7 12.8	8.7 9.6	7.5 8.3	16.7 18.8
Life expectancy, years $\left(\frac{2019}{2020}\right)$	73.3 71.5	78.0 76.7	82.9 82.3	81.4 81.1	83.6 82.4	82.9 82.8	78.9 77.3
COVID-19 mortality, % of infected*	1.8** (2.9)**	2.2 (2.3)	2.6 (1.3)	2.0 (1.6)	3.5 (2.3)	0.8 (0.6)	1.8 (1.5)
COVID-19 morbidity, % of population*	2.1 (7.2)	3.4 (10.8)	3.7 (14.6)	2.0 (8.4)	3.5 (9.7)	4.6 (14.7)	6.1 (16.4)

* Data as of December 30, 2020; in parentheses—data for December 30, 2021.

** Data of the Operational Headquarters for Preventing the Import and Spread of the Novel Coronavirus Infection on the Territory of the Russian Federation. According to short-term data of the Federal Bureau of Statistics (Rosstat) on natural population changes, the mortality rate from COVID-19 was 3.3% as of the end of 2020 and 5.3% for 2020–2021. The 2020 mortality rate from COVID-19 calculated based on annual Rosstat data on causes of death was 4.6%.

Source: Data of the OECD, the Federal Bureau of Statistics (Rosstat), and the Operational Headquarters for Preventing the Import and Spread of the Novel Coronavirus Infection on the Territory of the Russian Federation. URL: https://www.worldometers.info/coronavirus/.

Table 2. Contribution of the healthcare sector to the Russian economy and formation of human capital

Healthcare as economic activity	2012	2019	Germany (2019 or the closest year)	Healthcare as a social institution	2012	2019	Germany (2019 or the closest year)
Average number of workers, thousand people	4435	4181	6058	Decrease in mortality (per 1000 population)	13.3	12.3	11.3
Share of people employed, % of total number of people employed	7.8	7.9	14.3	Decrease in infant mortality (per 1000 live births)	8.6	4.9	3.2
Share in GVA, %	2.9	3.4	7.8	Birth rate (per 1000 population)	13.3	10.1	9.4
Share of fixed assets in total volume of fixed assets, %	2.2	1.4	4.9	Increase in life expectancy, years	70.2	73.3	81.4

Source: Data of the OECD and Rosstat.

national project "Health" (2004), state programs, and national and federal projects of 2018. The corresponding decisions led to significant, but isolated results in reducing morbidity and mortality of the population. The improvement in healthcare indicators was achieved despite the constant decline in the relative level of financing (% of GDP), constant underfulfillment of financial parameters of state programs for healthcare development, and the increasing gap between Russia and advanced economies in terms of resource availability in the sector (Table 2). In 2020 the share of healthcare spending (% of GDP) in Russia reached the maximum over the last 15 years of 7.1%, while in Germany it was 12.8%, in France 12.2%, in the United Kingdom 12.0%, and in the Czech Republic 9.2%. The share of the sector's added value is significantly lower than in advanced countries: in 2019 it was 3.4% against 9.0% in France, 7.6–7.8% in Germany, United Kingdom, and the United States, and 4.8% in the Czech Republic.

The established model of healthcare is focused on achieving results in individual areas, such as the development of primary care, reducing maternal and child mortality, and reducing mortality from cancer.

In this regard, measures of increasing salaries of health workers relative to the average salary have been significantly effective (Table 3). As a result, by 2019, before the COVID outbreak, the following results had been achieved:

— The infant mortality rate decreased from 8.6 per 1000 live births in 2012 to 4.9 in 2019, i.e., 1.8-fold (significantly ahead of the target value specified in strategic planning documents); the 2020 value was 4.5.

— Maternal mortality decreased to 9 deaths per 100000 live births in 2019 against 16.2 in 2011; in 2020 this indicator showed a significant increase to 11.2.

— Early neonatal mortality decreased 2.2-fold compared to 2012.

Table 3. Changes in health indicators and healthcare financing over time

Indicator	2005	2006	2010	2012	2019	2020	Target value for 2020 specified in the government program "Healthcare Development" (approved by Decree of the Government of the Russian Federation dated April 15, 2014 no. 294)
Life expectancy, years	65.4	66.7	68.9	70.2	73.3	71.5	75.0
Maternal mortality per 100000 live births	25.4	23.7	16.5	11.5	9.0	11.2	9.6
Infant mortality per 1000 live births	11.0	10.2	7.5	8.6	4.9	4.5	5.2
Mortality from all causes per 1000 population	16.1	15.1	14.2	13.3	12.3	14.6	11.4
Mortality from circulatory diseases per 100000 population	905.4	861.4	806.4	737.1	573.2	640.8	554.9
Mortality from neoplasms (including malignant) per 100000 population	200.6	200.1	205.2	203.1	203.5	202	190.0
Morbidity of acute viral hepatitis B per 100000 population	–	–	2.22	1.42	0.57	0.35	0.75
Number of patients with first-time active tuberculosis diagnoses (per 100000 population)	84	82.6	77.4	68.2	41.2	32.3	51.5
Early neonatal mortality (per 1000live births)	–	–	–	3.6	2.7	2.6	1.95
Public spending on healthcare, % of GDP	3.56	3.78	3.69	3.35	3.47	4.62	–
Ratio of the average monthly salary of doctors to the average monthly salary in subjects of the Russian Federation				141.0*	200.0	220.0	200.0
Ratio of the average monthly salary of midlevel health workers to the average monthly salary in subjects of the Russian Federation				80.4*	99.1	110.9	100.0
Ratio of the average monthly salary of junior health workers to the average monthly salary in subjects of the Russian Federation				47.8*	89.9	96.9	100.0

* 2013 data.

Source: Rosstat data.

— Morbidity of tuberculosis and hepatitis B decreased to levels significantly ahead of the target values specified in strategic planning documents.

Despite the measures taken, some of the goals could not be achieved, specifically the target values of mortality from circulatory diseases (although until 2019 there had been a steady positive trend) and malignant neoplasms, the overall mortality rate, and life expectancy.

However, the consequences of chronic underfinancing and the accumulating imbalances in the sector have revealed themselves in the aggravated situation during the epidemiological crisis of 2020 and the corresponding deterioration of qualitative parameters of public health (Table 3).

The limited financing was primarily associated with the so-called optimization of the sector: reductions in the number of employees in the sector, especially certain categories of health workers (junior and midlevel), and hospital beds. That decreased the availability of medical services and crippled the county's preparedness for pandemics. By 2019, compared to 2013, the number of target categories of doctors and health workers with medical higher education decreased by 2.4%, target categories of midlevel health workers (pharmaceutical personnel) by almost 9%, and junior health workers by more than 60%.

This personnel reduction was not uniform across regions. Thus, in Moscow the scale of optimization was more significant (Table 4). With the beginning of the pandemic, the problem of the critical shortage of medical personnel began to be gradually resolved, but often the shortage of doctors and other staff in some regions was covered by "pulling" human resources from other subjects, aggravating the epidemiological situation in the latter.

To sum up, by 2020 the healthcare system had accumulated the following imbalances:

Table 4. Changes in the number of health workers, % of 2013 values

Indicator	2019			2020			2021		
	Russia	Moscow	Perm krai	Russia	Moscow	Perm krai	Russia	Moscow	Perm krai
Doctors of all specializations	+1.7	–6.7	–0.1	+5.0	+6.5	–1.2	+5.6	+10.9	–4.4
Target categories of doctors and other health workers with medical higher education	–2.4	–9.1	–4.3	–1.3	–5.6	–5.5	–0.9	–1.7	–7.1
Infectious disease specialists	–6.5	–27.4	–3.3	+10.2	+33.3	–6.0	+8.1	+26.9	–10.7
Midlevel health workers	–1.8	–10.4	–5.9	–1.8	–3.6	–7.7			
Target categories of midlevel health (pharm.) workers	–8.9	–22.0	–14.2	–9.5	–21.5	–16.3	–10.4	–20.8	–17.8
Junior health workers	–61.5	–77.9	–85.9	–60.4	–76.3	–84.1	–58.5	–75.7	–80.6

Source: Rosstat data.

— High interregional disparity in terms of availability of doctors and other categories of workers, as well as the overall level of healthcare spending across subjects of the Russian Federation.

— An excess number of doctors of some specializations and a lack of others, both in general for the country and in specific regions.

— Insufficient availability, at both national and regional levels, of certain categories of personnel: junior and middle health workers, specialists with higher education employed in the healthcare sector (physicists, chemists, and others, in accordance with the classification of the Ministry of Health of Russia).

— Significant disparity between urban and rural areas in terms of medical personnel availability.

The established imbalances lead to the extreme overload of the healthcare system in 2020, which eventually resulted in an increase in mortality from all causes and in a high mortality rate from coronavirus in many regions, especially in 2021 (Table 5).

In 2021, the mortality rate from COVID-19 increased, compared to 2020, in all regions of Russia with the exception of Omsk oblast, the Republic of Tuva, and the city of Sevastopol; in some regions the increase was five-fold or more (Ryazan, Pskov, and Tyumen oblasts, the Republics of Bashkortostan and North Ossetia, and the Altai Republic). While the reliability of statistics on causes of death is tenuous, it is still a fact that resource availability in the healthcare sector is one of the determining factors of preserving citizens' lives. The group of regions with high, relative to the Russian average, mortality rates includes Krasnodar, Stavropol, and Altai krais, the Chuvash Republic, and Rostov and Penza oblasts. This group is characterized by generally low resource availability in the healthcare system (according to a comprehensive assessment). The group with relatively low, relative to the Russian average, mortality rates includes both Moscow with its high levels of population income and resource availability in the healthcare sector and relatively poor regions (Omsk oblast, the Republic of Tuva, and others).

There are also regions in which relatively high resource availability is accompanied by high mortality rates (St. Petersburg, Krasnoyarsk krai, and Murmansk oblast). Besides resource availability, the mortality rate from the coronavirus infection is affected by a number of other factors, in particular, population density, intensity of logistics flows and mass tourism areas, general health of the population, and morbidity of socially significant and chronic diseases. The gender and age structure of the region's population is another relevant factor. According to statistical reporting data on the gender and age structure of deaths in 2020, citizens aged 50 years and older were the most vulnerable in the conditions of the epidemic. This category was the most affected by excess mortality (the difference between the number of deaths in the corresponding gender and age groups in 2020 and the average values for the previous three years). In the gender and age structure of the Russian population, citizens aged 50 years and older make up about 36%. Meanwhile, in regions with low COVID mortality rates, such as the Chukotka Autonomous Okrug, Zabaykalsky krai, and the Republic of Tuva, the share of older citizens is significantly lower: 28, 29, and 20% respectively. Statistical analysis shows a high correlation between regions' indicators of the share of the population aged 50 and older and excess mortality.

The 2020–2021 pandemic has revealed inconsistency of health policies of regional authorities [6]. Introduction of strict control measures in some regions was accompanied by lifting of restrictions in others, which, along with the policy of stimulating domestic tourism, increased morbidity. In addition, problems of interaction and information exchange between municipal medical institutions and departmental organizations have also been highlighted: private clinics that could have reduced the load on the

Table 5. Regional disparity in terms of mortality from COVID-19 and resource availability in healthcare

Region	COVID-19 mortality rate, % of infected (as of December 31, 2020)*	COVID-19 mortality rate, % of infected (as of December 31, 2021)*	Increase in the mortality rate in 2021 compared to 2020**, %	Resource availability index***
Russian Federation	1.8	3.4	115	31.9
Regions with lower rates of COVID-19 *mortality in 2021 compared to the national average*				
Republic of Tuva	1.1	1.0	100	49.6
Tomsk oblast	0.9	1.2	116	39.0
Moscow	1.4	2.1	116	43.1
Omsk oblast	2.9	2.3	113	22.4
Regions with rates of COVID-19 *mortality in 2021 similar to the national average*				
St. Petersburg	3.2	3.3	116	45.5
Leningrad oblast	1.1	3.5	115	14.7
Republic of Crimea	2.0	3.8	117	13.4
Vladimir oblast	2.7	3.9	116	11.4
Regions with higher rates of COVID-19 *mortality in 2021 compared to the national average*				
Krasnoyarsk krai	3.7	5.5	116	35.3
Sverdlovsk oblast	2.6	5.6	114	23.7
Stavropol krai	2.1	5.9	117	10.1
Altai krai	2.7	6.6	116	16.9
Tula oblast	3.3	6.7	113	17.4
Krasnodar krai	3.4	9.7	120	8.4
Chuvash Republic	3.2	11.1	109	22.3

* On data of the Operational Headquarters for Preventing the Import and Spread of the Novel Coronavirus Infection on the Territory of the Russian Federation.

** Rosstat data.

*** The indicators of the regions' security levels and preparedness for the pandemic outbreak are based on 2019 data and include: (1) healthcare spending from consolidated budgets of subjects of the Russian Federation and budgets of territorial extrabudgetary government funds adjusted for price differences, per capita; (2) number of doctors per 1000 population; (3) number of midlevel health workers per 1000 population; (4) number of hospital beds per 1000 population; (5) number of ambulances per 10000 population; (6) indicator of availability of medicines (the ratio of the average monthly nominal accrued salary to prices of medicines, medical devices, and some medical services whose prices are monitored by Rosstat); (7) the ratio of doctor salary in the region, adjusted for the price differences, to the national average doctor salary; (8) the ratio of the salary of midlevel health workers in the region, adjusted for price differences, to the national average salary of midlevel health workers.The index is estimated as the sum of points assigned to the region depending on the value of physical indicators. The maximum value of the indicator is set at 9 percentile; regions with values above the maximum limit are assigned a value of 10. The minimum threshold value for indicators 1–6 is the first percentile, below which indicators take the value 0, for indicators 7–8—a value of 75% of the national average, below which indicators take the value 0. The indicators that are the most significant at any time, regardless of the epidemiological situation, (indicators 1–2, 6–7) were assigned weights of 1. The indicators that became especially significant and even critical during the epidemiological crisis (4–5) were assigned weights of 0.75. Indicators 3 and 8 were given weights of 0.5. The maximum possible number of points is 65.

Source: Data of the Operational Headquarter and Rosstat, authors' calculations.

public healthcare sector were almost entirely excluded from the system.

The increase in the number of deaths per 1 million population in Russia in 2020 compared to 2019 (2323 people) is higher than in advanced countries (United States 1481 people, Germany 473 people, Italy 1618 people). However, some subjects of the Russian Federation showed significant deviations from the national average in terms of this indicator, and it is likely that regional disparity in terms of resource availability in the healthcare sector was a contributing factor.

We have assessed the significance of the resource availability factor for increases in mortality from all causes across subjects of the Russian Federation by means of a regression analysis. The dependent variable was the indicator of deviation of the average increase in the number of deaths per 1 million population in 2020–2021 compared to 2019 in subjects of the Russian Federation from the corresponding national average value (*EM*—excessive mortality).

Since the object of assessment was preparedness of the healthcare system to an emergency epidemiological situation, the predictors were indicators compiled based on statistical data for 2019, specifically:

RI—the resource availability index (score) calculated in accordance with the methodological approaches described above.

LE—life expectancy (years) as a control variable and a generalizing indicator representing public health, achievements of the

Table 6. Estimation results of the LSq-model that calculates factors of influence on deviations of the average increase in the number of deaths per 1 million population in 2020–2021 compared to 2019 in subjects of the Russian Federation from the national average

Indicator	Full model with all factors		Reduced model with one factor	
	coefficient	*t*-statistic	coefficient	*t*-statistic
Constant	2.416	2.8	1.120	19.6
RI	–0.009	–4.5	–0.007	–3.5
LE	–0.025	2.1		
US	0.006	3.0		
Tr	0.191	3.0		
Adjusted R^2	0.301		0.113	
Schwarz information criterion (*BIC*)	11.400		21.500	

Source: Calculated by the authors.

healthcare system in the fight against socially significant diseases, and the population's commitment to a healthy lifestyle.

US—the share of urban population in the region's total population (%) as a control variable and an indicator of population density.

Tr—a dummy variable that represents correspondence of the region's mortality rate trend before the pandemic to the country-wide trend. Over the preceding 15 years, with some exceptions, the number of deaths in Russia had been decreasing. In 2019 compared to 2018 that decrease was about 2%; however, in a number of subjects of the Russian Federation the numbers of deaths had been increasing. This variable takes the value 1 if the region's mortality rate trend corresponded to the country-wide trend and 0 otherwise.

The parameters and the factors' significance levels for the model $EM = f(RI, LE, US, Tr)$ were obtained with the least-squares method (LSq). The results of the estimation of the LSq-model are presented in Table 6.

The regression analysis indicates significance of the model and factors; statistical tests have confirmed the absence of multicollinearity and heteroscedasticity and a normal distribution of errors.

The results of the analysis indicate that 30% of deviations of average increases in the number of deaths in subjects of the Russian Federation from the national average is determined by the influence of the selected indicators. According to the estimates of the reduced LSq model, regional disparity in terms of resource availability explains 11.3% of deviations of excess mortality in subjects of the Russian Federation from the national average.

The influence of the dummy variable is of particular interest: in regions that previously had decreasing mortality rates, which obviously suggests developed healthcare systems, the pandemic caused an additional increase in the number of deaths. We assume that this could be a result of larger older populations in these regions accompanied by an "overload" of the system that prevented citizens with chronic diseases who normally undergo elective treatment from receiving the necessary medical care on time in emergency situations. Thus, we have confirmed that it is imperative to ensure sufficient resource availability in the healthcare sector and establish emergency reserves.

Fixing the imbalances that have accumulated in the healthcare system requires not only a significant increase in the volume of financing, but also structural changes in terms of modifying the education system and training new highly qualified personnel, creating an effective system of territorial distribution of personnel, radically increasing availability of high-end equipment in the sector [7], and a transition to a new model of healthcare [8].

Outline of a new model of healthcare. The transition to a new model of healthcare characterized by greater availability and quality of medical services requires a significant increase in public and private funding. During the 2020 crisis, budget spending on healthcare increased to 4.6% of GDP, and total spending to 7.1% of GDP.[1] However, the budget for 2023–2025 indicates an insignificant increase in healthcare spending, even with the planned strategic government initiatives. Meanwhile, the funding volumes required for a new, modernized model of healthcare are 10.0–10.5% of GDP by 2035. That would bring Russia close to the current level of healthcare spending in advanced countries (the Netherlands 10%, the United Kingdom 10.3% in 2019).

[1] Total spending on healthcare includes budget spending, CHI funds, services covered with out-of-pocket payments (medical, fitness and sports, and convalescence and wellness services), and retail trade turnover for the following goods: products used for medical purposes, orthopaedic products, and medicines.

(1) The priority measures in the creation of a new model of healthcare should be ones aimed at solving personnel availability issues, elevating the status of health workers, and introducing a system of fair wages in the sector [9].

Currently, the healthcare sector is characterized by high interregional disparity in terms of personnel remuneration. Despite the implementation of the "May" decrees and the achievement of the stipulated salary ratios for the "target" categories of workers in the regions, salary levels adjusted for price differences may differ across regions 2–3-fold. The current system of setting the salaries of target categories of workers based on average nominal accrued wages in the relevant subject of the Russian Federation has led to increased interregional wage disparity. Therefore, the new model should use a universal national standard of remuneration with salaries of target personnel categories calculated based on the national average level of nominal accrued wages. Such a transition would cost the state budget an average of 450 billion rubles per year in 2025–2030. It would decrease the gap between regions in terms of wage levels adjusted for price differences to a 1.5-fold difference.

To implement a universal approach to remuneration of medical personnel and relative equalization of wages across subjects of the Russian Federation, the Government of the Russian Federation has adopted a Resolution no. 847 dated June 1, 2021, On Implementation of a Pilot Project in Order to Approve Requirements for Remuneration of Health Workers of State and Municipal Healthcare Institutions. It was planned to introduce a new system of remuneration for employees of healthcare institutions in 2021–2022 for seven pilot regions: the Republic of Sakha (Yakutia), Belgorod, Kurgan, Omsk, Orenburg, and Tambov oblasts, and the city of Sevastopol. Within this system, the wages include the official salary (depending on the group of positions), determined by multiplying the imputed value set by the Government of the Russian Federation by the coefficient of differentiation of position salaries depending on job complexity and coefficients representing economic differentiation of subjects of the Russian Federation, approved by the Government of the Russian Federation; compensation payments calculated in accordance with the unified list of such payments approved by the Government of the Russian Federation; and incentive payments in accordance with the unified list of such payments approved by the Government of the Russian Federation. Thus, the pilot project applies a universal centralized approach to the calculation of salaries in the healthcare sector, which should, firstly, help reduce wage disparity in the regions and, secondly, indirectly regulate the supply of doctors of a certain category in the labor market by changing the size of the official salary.

According to the draft Decree of the Government of the Russian Federation, On Approval of the Size of the Imputed Value, Groups of Positions of Medical Personnel of State and Municipal Healthcare Institutions in Order to Approve Position Salaries, Regional Coefficients, and Methods of their Calculation, Job Complexity Coefficients, a Universal List of Compensation Payments, a Universal List of Incentive Payments, the Amounts and Conditions of Compensatory and Incentive Payments for the Purposes of the Pilot Project, the proposed approach to calculating the official salary of health workers in regions based on the ratio of median wages and the median wages recorded in Kurgan oblast provides an increase in remuneration rates (with the current amounts of compensation and incentive payments) only in the 11 regions where median wages are lower than in this oblast. In the subjects of the Russian Federation where the median wages are higher, at the current amounts of compensation and incentive payments the effect of the new approach may be negligible, since the ratio of median wages remains unchanged. Considering that the pilot project did not include regions ranked lower than the Kurgan oblast, it is hard to assess the impact of the new remuneration system on interregional differentiation, since final wages include a large number of coefficients and additional payments.

Thus, this approach does not decrease wage disparity as such (since part of the more flexible regional supplementary payments system remains in force), but only disparity in the official salary for the 11 poorest regions. Nevertheless, such uniform principles of health workers' salary determination increase the transparency of the calculation of the part of wages that is approved on a centralized basis and increase its share in the regions where it is currently low.

The long-term goal is to bring the ratio of health workers' salaries to average salaries in the economy close to the corresponding ratios established in the labor markets of advanced economies.

The experience of the epidemiological crisis of 2020–2021 indicates the need to establish permanent additional payments to those categories of doctors and other medical personnel whose work is associated with direct contact with dangerous diseases or with other risks to their own life and health, specifically, for infectious disease specialists, radiologists, pulmonologists, and EMS workers. The total costs of implementing additional payments given an increase in the number of these specialists are estimated at 50 billion rubles per year.

It is also advisable to reconsider the approaches to determining salaries of midlevel health workers, which are currently formally the same as for junior health workers, making the profession unattractive. To increase availability of such personnel, the ratio of the salaries of midlevel health workers to the average sal-

ary in the economy should be raised to 130–150%, with corresponding allocation of financial resources.

Measures to increase the number of health workers are also necessary. Besides doctors, this also refers to the categories most affected by the recent optimization—midlevel and junior health workers. Additionally, it is advisable to create a number of education programs for these categories of health workers, aimed at expanding their job functions in order to partially reduce the burden on doctors, in particular, by delegating individual procedures of diagnosis, patient history collection, and filling out some statistical forms.

The number of these categories of personnel should be increased until the following ratios are achieved: the ratio of the number of midlevel health workers to doctors should be increased from 2.0 in 2020 to 2.6–2.7 workers per one doctor by 2035 (United Kingdom it is 2.7, Germany 3.1, Japan 4.7); the number of junior medical personnel to doctors from less than 0.5 in 2020 to 0.75–1.0 workers per one doctor by 2035. Raising the standards of ratios of these categories of healthcare workers requires an additional 300 billion rubles of budget funds per year for 2025–2030.

In addition to increasing the number of junior and midlevel health workers, another measure necessary for improving the efficiency of the healthcare system is a significant increase in the number of technicians who operate medical equipment and perform data processing tasks. Without an increase in their number, effective use of equipment will not be possible, even if equipment availability in Russian clinics is increased manyfold in order to reduce the lag behind advanced countries in terms of equipment availability.

(2) Russia is currently significantly behind the OECD countries in terms of the capital to labor ratio in the healthcare sector. In 2021 the sector's capital to labor ratio per person employed was $18000, while in Germany the corresponding indicator is estimated at $194000, in the Czech Republic at $102000, and in France at $75000 (2020).

Improving the quality and efficiency of medical services requires a significant increase in the capital to labor ratio: providing medical institutions with modern diagnostic equipment (CT, MRI, PET scanners, gamma cameras, etc.). Availability and effective use of high-end equipment would, most notably, improve diagnosis quality and help detect diseases at early stages.

(3) The drastic epidemiological situation of the past two years has vividly highlighted the necessity of developing and supporting the research and development base of the healthcare sector. Currently, the share of domestic spending on medical R&D in Russia is 0.04% of GDP, while in the Czech Republic it is 0.1% of GDP, in Korea and Portugal 0.2% of GDP, in the Netherlands 0.3% of GDP, and in Denmark 0.9% of GDP. Achieving the national goals related to health and wellbeing of the population and ensuring sanitary and epidemiological security requires a significant increase in state and business spending on research in the fields of medicine, biotechnology, and pharmaceutical development up to a comparable to advanced countries level of 0.3–0.4% of GDP.

The pandemic has also revealed that the medical education system needs restructuring in the direction of expanding the range of acquired competencies in order to increase specialists' interchangeability and conduct comprehensive treatment. Training new doctors and other health workers will take many years; therefore, a possible short-term solution to the shortage of doctors and other medical personnel is utilizing the migration resource, specifically attracting health workers from Cuba, which has the ability and experience of exporting high-quality medical services and highly skilled personnel.

(4) A number of regulatory and organizational changes in the sector are also required. The particular objectives are to raise the status of the medical profession and revise criteria of criminal liability for medical errors. It is also advisable to replace the CHI system for the ambulance service and for medical institutions specializing in the treatment of infectious diseases (epidemics) with the formerly used budgeted funding, as the nature of these expenses is not well compatible with insurance cases.

Methodology of forecasting the development of the healthcare sector in the medium and long term and its contribution to the socioeconomic situation in the country. The role of healthcare in socioeconomic development can be considered from two separate viewpoints. On the one hand, healthcare contributes to GDP growth directly through the provision of medical services and remuneration of employees, i.e., through generation of added value. On the other hand, healthcare creates conditions for improving the quality of human capital employed in all sectors and spheres of the economy by improving workers' health and, consequently, their work capacity and performance and reducing economic losses from the potential maximum natural decline in population and labor force and from production downtime caused by sickness-related absences. In these terms, the sector's effect on socioeconomic development is more far-reaching and more difficult to measure.

In economic research the impact of the healthcare sector and the level of public health on GDP is estimated using the Cobb-Douglas production function:

$$Y = AK^{\alpha} L^{1-\alpha},$$

where Y is GDP growth, K is accumulated fixed capital, L is labor resources, and A is total factor productivity.

Within total factor productivity, the factor of human capital is distinguished separately. The originator of the concept of "human capital" G. Becker defined it as "experience, education, healthcare, and training" [10, 11]. Thus, this factor is made up of two

properties: knowledge and health levels of the population. However, to date, research literature has not developed a single standardized approach to quantitative assessment of human capital and its impact on total productivity.

In the traditional approach, the component of human capital that corresponds to public health is measured by indicators that directly represent the number of people employed and their work capacity: the mortality rate, the inverse indicator of life expectancy at birth, and adult survival rates (see, for example, [12–14]).

In addition to the life expectancy indicator, some studies also consider how labor productivity is affected by morbidity of various socially significant diseases (see, for example, [15]).

The traditional approach was later expanded to include qualitative parameters that represent the education and healthcare sectors. The parameter commonly used to represent the education factor is students' knowledge level, measured as the average score on the international PISA test in OECD countries [16]. Determining the health indicators that affect labor productivity is more difficult due to the complexity of this factor. The current state of a person's health is determined not only by sickness in adulthood, but also by genetic factors, childhood medical history, childhood nutrition, and the course of pregnancy and the mother's health. Study [17] introduces the term "latent" health, characterized by a set of parameters and estimated based on indicators of adult population height, adult survival rates, and average age at menarche. It was also found that there is a relationship between height indicators and adult survival rates. This approach, the specified factors, and the obtained estimates of elasticity coefficients are currently used in World Bank calculations of the human capital index.

Another approach is to measure human capital by financial indicators, such as healthcare spending (% of GDP) [18] or accumulated healthcare spending that represents investments in human capital similarly to investments in fixed assets [19].

An approach that integrates the above is proposed in [20]. The main dependent variable in the study is the indicator of real GDP growth per capita averaged for five years. The main independent factors were indicators of accumulated education and health capitals, as well as changes in these indicators. Education capital was measured as primary and secondary school enrolment, and health capital was approximated as the mortality rate of children under five. To identify the factors of influence on the indicators of education and health capitals, separate regression models were developed: the independent variables were the spending on education, % of GDP, on average over the last five and the previous five years and the average share of healthcare spending in GDP over the last five years.

The results of the study showed that healthcare spending has a positive effect on health capital.

In the present study, based on the established international and Russian practice, the impact of healthcare spending accumulated over a three-year period on GDP growth is estimated using the production function. Thus, the factor of labor resources (person-hours completed) is adjusted for a parameter that represents the quality of human capital expressed as investments in its development.

The analysis involves three forecast scenarios of the sector's development that differ in financing volumes and the degree of implementation of healthcare development measures: baseline, moderately optimistic, and optimistic (see further).[2]

The baseline version assumes preservation of the current trends in the sector that prioritize development of individual areas of medicine and social support specified in strategic planning documents. The limited financial resources and fragmented support for the sector will be enough to ensure the achievement of the goals set in national projects, but not to make a "breakthrough" in the sector as a whole and bring it up to the level of advanced countries.

The moderately optimistic version assumes a transition to a new model of healthcare, which involves creation of a new wage system and mostly overcoming personnel imbalances. In order to implement all measures required for the new development trajectory, healthcare spending needs to increase to 9.0–9.5% of GDP by 2035. The increase is necessary to expand the sector's coverage of areas and directions in order to ensure comprehensive development of the entire system rather than individual "target" blocks.

The optimistic version sets the goal of catching up to advanced countries in terms of the development of healthcare, education, and science. In this scenario, healthcare expenditures reach 10.5–11.0% of GDP by 2035 and the availability of high-end medical equipment significantly increases. The share of investments in fixed assets in the sector in total healthcare spending increases from 6.7% in 2019 and 9.6% in 2020 to 12.5–13.0% by 2035. This scenario can result in significant improvement of qualitative indicators of public health.

Based on the production function, it is estimated that the increase in healthcare financing and the resulting improvement in public health would have a significant effect on economic growth. If in the baseline scenario the contribution of accumulating healthcare resources to GDP is an increase by 0.8 percentage points by 2030 (about 0.1 percentage points per year), in the optimistic version the GDP growth by the same year is higher by additional six percentage points (0.6 percentage points per year).

Besides the overall level of economic development, the scale of healthcare spending influences such

[2] The forecast scenarios are described in more detail in [9].

Table 7. Estimation results of the LSq model that calculates factors of influence on the mortality rate

Indicator	Coefficient	*t*-statistic
Constant	5.406	5.1
Spend_doc	–0.300	–3.5
Doc_N	–0.652	–4.0
Alcohol_consumption	0.002	20.0
Share_smoking	0.055	1.8
Neoplasm_capita	0.020	10.0
Adjusted R^2	0.789	

Source: Calculated by the authors.

parameters of human capital quality as mortality, life expectancy, and morbidity.

Based on 2019 data on subjects of the Russian Federation, we have estimated the influence of various factors on the mortality rate, specifically:

— Healthcare expenditures from the consolidated regional budget and regional extrabudgetary funds, adjusted for regional price differences, per doctor, mln rubles.

— Number of doctors per 1000 population.

— The ratio of the number of midlevel health workers to doctors as an indicator of the burden on doctors.

— Number of hospital beds per 1000 population.

— Number of ambulances per 10000 population.

— Availability of medicines and medical devices, calculated as the number of sets of all medicines and medical devices monitored by Rosstat which a resident of the region can buy on an average monthly salary.

The above variables represent characteristics of resource availability in the regions, which were supplemented with qualitative parameters of public health,[3] specifically:

— Number of patients with alcohol-use disorder and alcohol-related psychoses registered at healthcare facilities per 100000 population.

— Number of patients with drug addiction registered at healthcare facilities per 100000 population.

— The share of daily smokers in population aged 15+.

— First-time malignant neoplasm incidence per 100000 population.

— Incidence of circulatory diseases per 1000 population.

[3] Factors of influence on health status are defined, in particular, in OECD reports (see, for example, [21]).

According to the results of the conducted statistical testing and sequential exclusion of factors, the model that showed the best performance was the following:

$$Mort = F(Spend\_doc;\ Doc\_N;\ Alcohol\_consumption;\ Share\_smoking;\ Neoplasm\_capita),$$

where *Spend_doc* is healthcare spending from the consolidated regional budget and regional extrabudgetary funds adjusted for regional price differences per one doctor; *Doc_N* is the number of doctors per 1000 population; *Alcohol_consumption* is the number of patients with alcohol-use disorder and alcohol-related psychoses registered at healthcare facilities per 100000 population; *Share_smoking* is the share of daily smokers in population aged 15+; and *Neoplasm_capita* is first-time malignant neoplasm incidence per 100000 population (Table 7).

Thus, the difference between the forecast scenarios in terms of the mortality rate can be estimated based on forecasts of budget healthcare spending, changes in the number of doctors, and some qualitative parameters of public health.

Decreases in the mortality rate in the scenarios correspond to the so-called "excess mortality." Excess mortality losses are estimated based on the Methodology for Calculating Economic Losses from Mortality, Morbidity, and Disability of the Population approved by Order of the Ministry of Economic Development of the Russian Federation, the Ministry of Health and Social Development of the Russian Federation, the Ministry of Finance of the Russian Federation, and the Federal State Statistics Service dated April 10, 2012 no. 192/323n/45n/113 (hereinafter the Methodology).

According to the Methodology, economic losses from excess mortality in GDP terms are calculated as profits lost due to a person's absence from the sphere of production in a certain year. In addition, potential losses are calculated for the period of the remaining potential life expectancy of those deceased in the reporting year based on life expectancies for the corresponding ages.

Economic losses from mortality are calculated as the product of the number of deceased aged 15+ by GDP per person employed adjusted for the employment rate of the corresponding gender and age group and averaging the time of death within the year (a correction factor of 0.5). The calculations are additionally adjusted for the reduced working hours and extended vacation time of people aged 15 to 18 years.

Economic losses from population mortality for a reporting year are calculated according to the following formula:

$$PLMY_{x,s,d} = ND_{x,s,d}\frac{NE_{x,s}}{PS_{x,s}}\frac{GDP}{NE} \times 0.5K_x, \quad (1)$$

where $PLMY_{x,s,d}$ is profit losses in terms of GDP (the volume of GDP not generated) resulting from mortality of persons aged (x) of gender (s) due to cause of death (d) in the Russian Federation in the reporting year; $ND_{x,s,d}$ is the number of deaths at age (x) of gender (s) due to cause of death (d) in the Russian Federation; $NE_{x,s}$ is the number employed people of age (x) and gender (s) in the Russian Federation (based on data for five-year age groups); $PS_{x,s}$ is the size of the population group of age (x) and gender (s) in the Russian Federation (for the sake of comparability, based on data for five-year age groups); NE is the number of employed peo-

ple in the Russian Federation; K_x is a correction factor for the reduced working hours and extended vacation time of people aged (x) under 18 years (for $x = 15$ $K_x = 0.5922$, for $x = 16$ $K_x = 0.8636$, for $x = 17$ $K_x = 0.8636$, and for $x > 17$ $K_x = 1$); 0.5 is the coefficient for the distribution of times of deaths within the year.

Total economic losses are calculated as the sum of the economic losses for each differentiating factor.

Due to insufficiency of accessible and open statistical data, this study uses a modified version of the Methodology: specifically, the mortality structure is considered only in terms of gender and age (by five-year age groups); causes of death are excluded from the analysis.

Thus, the resulting difference between the forecast scenarios in terms of the number of deaths is distributed by age and gender in accordance with the accepted structure of reporting population mortality. The GDP calculated with formula (1) represents the potential GDP that could have been generated by deceased citizens had they remained alive. The value added by one person employed is taken from a macroeconomic forecast of the VEB Research and Expert Review Institute. In each subsequent year, the excess mortality of the previous year for each age group and gender is increased by the number of excess deaths of the previous year who have moved to the next age group with the corresponding survival rate for this age. Thus, the effect of excess mortality accumulates every year and persists in the long term, even if there is no excess mortality in subsequent years. The GDP calculated by formula (1) represents economic losses from excess mortality.

The methodology estimates the direct effects on GDP associated with decreases in the number of people employed. However, this kind of analysis is not capable of representing the valuable contributions of older age groups (for example, 81% of doctorate-level researchers were over 55 years old as of 2020, of which about half were over 70 years old). Another missing factor is the unpaid labor performed by people over the working age—childcare, elderly care, etc.—which also has value both for individual families and society as a whole; besides that, older people are also keepers of cultural values between generations.

Assessing the full indirect contribution of people over the working age to the social and economic sphere does not seem possible. However, this contribution can be partially represented via a statistical indicator "the share of people aged 55+ whose daily activities include unpaid childcare (for their own children or children of other people)" by adding this category of citizens to the main account under the Methodology for the corresponding age groups. In 2018, the shares of childcare providers among people aged 55 and older was 10.5% for men and 18.0% for women, which is significant.

In addition, citizens over the working age form a separate sector of the economy, which includes the provision of special social and medical assistance and certain types of tourist and recreation services. However, these directions cannot be included in the account as they relate to the formation of demand, i.e., to the account of GDP use.

The Methodology estimates morbidity losses in the same way as mortality losses. The decrease in employment within the year is estimated based on the average duration of one case of sickness-related temporary incapacity for work.

The implementation of the new healthcare model projected in the optimistic forecast scenario would result in qualitative achievements in human capital development and morbidity reduction. In particular, promoting healthy lifestyles, reducing tobacco and alcohol consumption, increasing personnel availability in the sector and reducing the burden on doctors, and improving resource availability in healthcare institutions would reduce the overall morbidity rate by 28% by 2035 compared to 2019. The GDP losses associated with the reduction in the number of people employed in the economy but absent from production due to illness would decrease by 1.05 percentage points by 2035 compared to 2019.

The implementation of additional measures and the increase in financing of the sector would result in a reduction of the mortality rate by 600 people per 100000 population by 2035 and the achievement of the national goal "Increase in life expectancy to 80 years by the end of the period." The associated reduction of GDP losses from excess mortality would amount to an average of 0.24% per year in 2022–2035 (compared to the baseline scenario), or 4.7 trillion rubles by the end of the period in 2020 prices.

Thus, the scale of healthcare spending determines the level of public health and stimulates economic growth.

The financial resources necessary for the development of the sector are forecasted based on the balance method, in which sources of financial resources are linked to main directions of their expenditure.

$$S_H = TC,$$
$$S_H = S_{HG} + S_{HP},$$
$$TC = LR + I + Sv + M + O,$$

where S_H is spending on healthcare including government expenditures (S_{HG}) from the federal budget, consolidated budgets of subjects of the Russian Federation, CHI funds, and household out-of-pocket payments (S_{HP}, household out-of-pocket payments); TC (total costs) are expenses, including labor remuneration (LR), investments in fixed assets (I, investments), spending on transport, utilities, and other services (Sv), on materials (medicines, wound care supplies, accessories, etc.) (M), and other expenses (O).

The main source of funding for the sector is the state budget, and one of the main expenses is remuneration, due to the high number of skilled specialists employed in the sector. Therefore, the fundamental

aspect to forecast is the number of employees across sectors of the economy (public and private) and personnel categories (doctors, midlevel health workers, junior health workers, social workers, and others).

In the medium term the number of doctors and midlevel health workers is largely determined by the number of citizens enrolled in medical programs of secondary and higher professional education. Thus, the number of specialists that will be available over the next six years is determined based on the number of graduates of higher and secondary vocational education institutions and the current trend of retirement of relevant specialists. In the following years the trends of the number of health workers of middle and high skill levels will be determined by changes in the population aged under 18 and the current ratio of students enrolled in medical programs of secondary and higher professional education in the total number of corresponding groups of students, as well as the ratio of graduated specialists to those enrolled in medical programs with a six- or three-year lag.

The optimistic forecast scenario sets the goal of the number of doctors per 1000 population being no lower than the current national average in every subject of the Russian Federation. The number of midlevel health workers is forecasted assuming achievement of the ratio of 2.6–2.7 midlevel health workers per doctor, which is comparable to the average ratio in OECD countries.

Given that the significant reduction in the number of junior health workers was part of the optimization of the healthcare sector that had negative consequences revealed during the 2020–2021 pandemic, the optimistic scenario assumes accelerated growth in the number of this category of workers in the forecast period, so that the ratio of their number to the number of doctors would by 2035 reach 0.8–1.0.

The average number of social workers is determined by the trend of the number of citizens who may need care due to advanced age (over 60 years old).

The number of health workers is also adjusted for morbidity rates of citizens of different ages and, accordingly, for the forecasted population sizes of the corresponding age groups.

The forecast of the number of people employed in the healthcare sector determines budget spending on remuneration. The wages of the discussed categories of workers are projected based on the forecast of socioeconomic development developed by the VEB.RF Institute and established by the 2012 Decrees on ratios of salaries of target categories of workers and the average monthly salary in the relevant subject of the Russian Federation.

The optimistic scenario also assumes accelerated increase in the salaries of health workers starting from 2026 so that in the long term the ratios of salaries of health workers and the average salary in the economy

Table 8. Healthcare development scenarios for the period until 2035

Indicator	Current model (baseline scenario)	Development models	
		moderately optimistic scenario	optimistic scenario
Total healthcare spending, % of GDP	6.2–6.3	9.0–9.1	10.3–10.5
of which:			
budget system spending	4.0–4.2	6.0–6.1	6.5–6.7
private spending	2.2	3.0	3.7
Share of investments in fixed capital in healthcare spending, %	7.0–7.2	9.2–9.4	10.5–11.0
Capital to labor ratio, thousand dollars, in 2018 prices per person employed in the sector	38–40	67–70	82–85
People employed, million people	5.2–5.3	5.8–6.0	6.5–6.6
of which:			
doctors	0.81	0.92	0.98
midlevel health workers	2.02	2.45	2.72
Ratio of MLHWs to doctors	2.5	2.7	2.8

Source: Calculated by the authors.

reach the corresponding indicators of the labor markets of advanced countries.

Investments in fixed assets are forecasted based on the measures indicated in strategic planning documents (Table 8).

In the baseline scenario with limited healthcare financing, this indicator is expected to increase at a moderate rate of an average of about 2.5% per year. The ratio of the volume of capital investments in the sector to GDP will remain at the 0.4–0.5% level, which corresponds to smaller OECD countries. In the moderately optimistic scenario, the average annual growth rate of investments in the sector is assumed to be about 108.5%. In that case, by 2035 Russia is expected to reach the current level of the United States in terms of the ratio of capital investments to GDP. The optimistic scenario assumes widespread availability of modern diagnostic equipment (CAT, MRT, PET scanners, gamma cameras, etc.) at medical institutions, leading to improvements in the quality of diagnosis and detection of diseases at early stages, which will also allow doctors to delegate the work of patient history collection to other categories of health workers. In view of the large territory of the country and the state of medical institutions in remote and rural areas, the average annual growth rate of investments during the forecast period is expected to be over 110%, and in terms of the ratio of investments in the sector to GDP Russia is expected to exceed the current level of OECD countries by 2035.

Expenses for transport, utilities, and other services are forecasted based on the growth rate of services covered out of pocket, adjusted for the deflator index; other expenses in the sector are forecasted based on the overall economic growth rate.

In addition to state budget funds, another source of financing of the healthcare sector is out-of-pocket payments for services related to healthcare and wellness and for medicines and medical devices. Services covered out of pocket include medical services, fitness and sports services, and convalescence and wellness services. The amount of funds spent by the population on medicines and medical devices is determined based on data on visits to public and private medical institutions for the purposes of treatment or prevention, adjusted for changes in the consumer price index.

Public health is the foundation of socioeconomic wellbeing of the country and sustainable long-term economic growth. Therefore, investments in development and modernization of the healthcare sector are an imperative for a transformation from a "society of the poor and sick" into a society of the "healthy and rich."

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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