

**Master's Thesis
Cover Page**



Master's Thesis

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Descriptive analysis of two-year mortality from all causes during the Covid-19 pandemic in Russia

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Abbreviations

WHO - World Health Organization

VOC – Variant of concern

VOI – Variant of interest)

Ruble – Russian currency P

VDNH - Exhibition of Achievements of the National economy - public Park

Ministry of Defense - Ministry of Defense of the Russian Federation (army forces)

CT centres - Diagnostic centers

Rosstat - Federal State Statistics Service

Stopcoronavirus - The official Internet resource for informing the public about coronavirus (COVID-19)

RF - RUSSIAN FEDERATION

CFD - CENTRAL FEDERAL DISTRICT

NWFD - NORTH-WESTERN FEDERAL DISTRICT

SOUTHERN FD - -SOUTHERN FEDERAL DISTRICT

NCFD - -NORTH CAUCASUS FEDERAL DISTRICT

VFD - VOLGA FEDERAL DISTRICT

UFA - URAL FEDERAL DISTRICT

SIBERIAN FD - SIBERIAN FEDERAL DISTRICT

FEFD - FAR EASTERN FEDERAL DISTRICT

«Rospotrebnadzor» - FEDERAL SERVICE FOR SUPERVISION OF CONSUMER RIGHTS PROTECTION AND HUMAN WELFARE

Declaration of Authorship

I hereby certify that this thesis has been written by me and is based on my own work. All quotes, references and verbatim extracts have been cited accordingly. All sources of information, including graphs and data sets, have been specifically acknowledged. No other person's work has been used without due acknowledgement.

Date: _____

Signature: _____

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Abstract

Background

As many other countries, Russia has been severely affected by the ongoing COVID-19 pandemic, which has spread across entire territory. However, all-cause mortality, which increased during COVID-19, remains poorly understood due to deficiencies in surveillance and analytics. The problem of morbidity from Covid-19 has quickly developed into a critical situation for all residents, especially for the health care system. Unfortunately, it still poses a severe threat to the population. Mortality from all causes during the COVID-19 pandemic was significantly higher than in previous years. In Russia, according to official data, 4.5 million people died (as of December 31, 2021). The author aims to estimate the change in mortality during the pandemic in Russia using data on mortality from all causes.

Methods

The data of our study combined information from several sources. Firstly, the "Federal State Statistics Service, Rosstat" data we used is stored for public use on the official website. Therefore, the author has collected monthly information for each region and district of the country. Secondly, a daily chronology of events was created based on the Internet resource "Stop coronavirus. RF" data. Thirdly, the expected mortality was predicted and estimated using a linear model. The model selection was based on MSE and MAE measurements. Finally, each region was analyzed using descriptive statistics and stratified by districts.

Results

From 2006 to 2021, data on deaths from all causes were analyzed. Over the past 15 years, mortality in the country has decreased by 1% annually. The author describes and evaluates the two-year mortality from all causes during the pandemic in Russia. The mortality rate is mainly high in the European part of the country; when moving in an easterly direction, mortality decreases significantly. We note the highest mortality rate during pandemics in the last 15 years. The expected mortality is considerably lower than observed in most regions and countries.

Conclusion

The surge in deaths detected in the last two years can be most likely attributed to the impact of the pandemic on the population. The most significant number of registered deaths from all causes were recorded in large settlements and adjacent territories. Our results highlight the importance of correctly

and timely collecting information about all-cause mortality and make them publicly available to allow investigations of direct and indirect effects as well as potential consequences.

Keywords: all causes deaths, Russia, descriptive statistics, COVID-19, linear model

Introduction

On December 31, 2019, the Chinese government informed the World Health Organization about an outbreak of unknown pneumonia in the city of Wuhan in the central part of the country (Hubei Province) [27]. Earlier, in the first middle of January 2020, it turned out that this had gone beyond the borders of China; episodes of the disease were noted in other states. Therefore, on January 27, 2020, an operational headquarters in the field of interaction with relevant executive authorities was established in the Russian Federation to form measures to prevent the import and spread of new coronavirus infections Covid-19. [9]

The initial episodes of coronavirus disease in the Russian Federation were detected on January 31. On February 2, the coronavirus infectious disease 2019-nCoV was included in the list of diseases that pose a danger to others. In the future, there were suspensions of flights to European cities, starting with Italian ones. Since March 23, the Russian Federation has restricted air traffic with absolutely all countries of the world. March 30 from 00: 00 min. [12] According to the capital time, traffic was temporarily restricted using cars, railways, pedestrians, river and hybrid checkpoints across the state border of Russia. In the Capital, due to the danger of the spread of coronavirus, on March 5, a high-alert mode was established. At the same time, administrations began to implement limited measures to combat the spread of coronavirus. On March 25, the President of Russia made a televised address to the residents of the Russian Federation, in which he announced the beginning of the lockdown. [41] From March 30, a home self-isolation regime was established in the Capital. In the future, all regions of the Russian Federation, without exception, declared self- isolation, except for the Tver Region - a high-readiness order was established there. On April 2, the head of Russia, in his new televised address to residents, announced the extension of the period of non-working days until April 30. Since April 15, the Capital's government has introduced digital passes for moving around the city on public transport. In addition, digital passes were introduced in the Moscow Region, Primorye, certain regions of the Volga Region, the Krasnoyarsk Territory and several regions. [41]

In general, due to the pandemic, every second region of the Russian Federation included a particular mode of movement. On April 30, the total number of cases in the Russian Federation overcame the milestone of 100 thousand. On May 11, the Head of the Russian Federation announced the completion of the general stage of non-working days in the country established due to the spread of coronavirus from May 12. [9] With the spread of coronavirus, the Russian Federation began to create a vaccine for COVID-19. In August, the Ministry of the Russian Federation registered the first vaccine to prevent COVID-19, investigated by the Gamaleia Research Center. It was named "Sputnik V"[17]. In October, another Russian vaccine, EpiVacCorona [34], was registered and developed at the Vector

centre of Rospotrebnadzor. On February 20, 2021, it became established that the Ministry of Health registered the COVID-19 vaccine "KoviVak", based at the Federal Scientific Center for Research and Development of Immunobiological Drugs, named after M. P. Chumakov of the Russian Academy of Sciences. [41]

By December 15, the Covid-19 vaccine was delivered to all regions of the Russian Federation without exception, and immunization began in the Capital on December 5. [41] On January 18, mass immunization against coronavirus began in Russia. The emergence of COVID-19 has identified issues related to emergency diagnosis and the provision of medical care to the sick before health experts. [9] Today, an active study of the medical and epidemiological properties of the disease continues, the development of new means of its prevention and treatment. According to WHO, Russia is among the top 10 countries in terms of the prevalence of Covid-19 (in the world) [47]. As of January 1, 2022, more than 600 thousand deaths from Covid-19 were registered (in total). However, the actual number of deaths is unknown. The incidence of Covid-19 has rapidly escalated into a critical situation for all residents, especially for the healthcare system. Unfortunately, it still poses a severe threat to the population. The actual numbers and causes of death in humans are difficult to determine and may differ from those registered due to the lack of available test systems and various death classifications. [38] Since they cannot be compared, it is impossible to correctly assess the impact of various interventions (lockdown, anti-epidemic measures, vaccination). In countries with a high standard of living, more accurate analytics and data collection on mortality from all causes made it possible to more rationally and objectively understand the spread and impact of the virus on the population.

This master's thesis describes the two-year mortality from all causes during the pandemic in Russia. The thesis is structured as follows: first, it gives a general description of the state, an overview of the state of the healthcare system in Russia and a chronology of the pandemic by month. The data sources, research design and methods are described. Finally, the results obtained are described in comparison with previous years. As a result, a conclusion was made, and an assessment and recommendations of the healthcare system were given.

Epidemiology of the pandemic and public health in the country.

Russia is located in the Northern Hemisphere. It borders eighteen countries and has land borders with Norway, Finland, Estonia, Latvia, Lithuania, Poland, Belarus, Ukraine, Abkhazia, Georgia, South Ossetia, Azerbaijan, Kazakhstan, China, Mongolia and North Korea. The maritime borders are with Japan and the USA. The Capital is Moscow. [1] The population is 146764655 people as of January 1

2019. There are 227 airports in Russia, and the average annual flow of passenger traffic is million people ~200 per year. [43] The register of seaports of Russia includes 151 ports.

Overview of healthcare in Russia

Hospital organizations in the healthcare system provide medical care to hospitalized patients. In hospital organizations, beds equipped with the necessary equipment are subject to accounting, regardless of whether patients occupy them or not. The number of hospital organizations at the end of 2019 amounted to 5,130 throughout Russia. The number of outpatient polyclinic organizations includes all medical organizations that conduct outpatient admission (polyclinics, outpatient clinics, dispensaries, and polyclinic departments as part of hospital organizations), while the number of outpatient polyclinic organizations at the end of 2019 was 21216. At the end of 2019, the number of hospital beds is only 1173568 units. The total number of doctors and secondary medical personnel includes persons with higher medical education and with secondary medical education, respectively, employed in medical and preventive organizations, organizations of supervision services in the field of consumer protection and human well-being, social security institutions, clinics of universities and research institutes, preschool institutions, schools, children's homes.[15] In Russia, the number of doctors does not include graduate students, clinical residents, or interns. The number of medical personnel at the end of 2019 was: 714.6 —doctors and 1491,3 secondary medical personnel. The number of ambulance stations is 2211—the number of people who received outpatient and on-site care, people:45.7 total million. [9]

The population's morbidity is characterized by the number of diseases detected (or taken under dispensary supervision) during the year when contacting medical and preventive organizations or during a preventive examination. [2] Primary morbidity is recorded when a patient is diagnosed for the first time in his life. The general morbidity of the population is characterized by the total number of cases of diseases registered during the year. The population's morbidity by the main classes of diseases in 2019 amounted to 114512 thousand (diseases were registered in patients with a diagnosis established for the first time in their lives). The leading cause of death of Russians is various diseases. Only 5% of the population die of old age, 7.9% from external causes, in particular, 1% from transport accidents, and 0.8% of the deaths in road accidents. [10]

Epidemiology of the pandemic

Based on the daily reports of Rospotrebnadzor, the first two cases of COVID-19 infection were registered in Russia on January 31, 2020, following the route of the PRC-the Trans-Baikal Territory

and the PRC-the Tyumen Region. It was the first official mention of the presence of the virus in the country. [9]

Virus strains

Based on the prevalence of various variants of the virus among the population and data on their biological properties (contagiousness, pathogenicity, attitude to the neutralizing activity of antibodies), the WHO proposed to identify options of concern (VOI – variant of concern) and options of interest (VOI – variant of interest). VOI - is widely distributed in many countries of the world and has mutations capable of changing their biological properties, but there is currently no evidence of this.[48] VOC and mutations have biological properties that increase the contagiousness and pathogenicity or reduce the neutralizing activity of antibodies.[20] To date, variants alpha- (PANGO line B.1.1.7, first discovered in the UK in September 2020), beta- (PANGO line B.1.351, first discovered in South Africa in May 2020), gamma- (PANGO line P.1, first discovered in Brazil in November 2020) and delta- (PANGO line B.1.617.2., first discovered in India in October 2020) and omicron (PANGO line B.1.1.529., first discovered in South Africa and Botswana in November 2021) are classified as VOC variants. Variants of lambda and mu - refer to VOI. [5]

Vaccines

The following vaccines have been registered in the Russian Federation for the specific prevention of COVID-19 [45]:

The combined vector vaccine "Gam-COVID-Vac" was obtained biotechnologically, in which the SARS-CoV-2 virus is not used. The drug consists of two components: a recombinant adenovirus vector based on human adenovirus 26 serotype, carrying the SARS-CoV-2 S-protein gene (component I) and a recombinant adenovirus vector based on human adenovirus five serotypes, carrying the SARS-CoV-2 S-protein gene (component II).¹ The vaccine "GamKOVID-Vac" is used to prevent COVID-19 in adults over 18.[17]

The Sputnik Lite vaccine is a recombinant adenovirus vector based on the human adenovirus 26 serotype, carrying the SARS-CoV-2 S-protein gene and is used to prevent COVID-19 in adults over 18 years of age.

The vaccine "Gam-COVID-Vac-M" is a recombinant adenovirus vector based on the human adenovirus 26 serotype, carrying the SARS-CoV 2 S-protein gene (with a reduced content of

adenovirus particles), and is used for the prevention of COVID-19 in adolescents aged 12 to 17 years (inclusive).

The vaccine based on peptide antigens ("EpiVacCorona" and "EpiVacCorona-H") is a chemically synthesized peptide antigen of the S protein of the SARS-CoV-2 virus, conjugated with a carrier protein and adsorbed on an aluminium-containing adjuvant (aluminium hydroxide). The EpiVacCorona vaccine prevents COVID-19 in adults over 18 years of age. The EpiVacCorona-H vaccine is used in adults aged 18-60 years. [34]

The inactivated vaccine ("CoviVac") is a purified concentrated suspension of the SARS-CoV-2 coronavirus strain "AYDAR-1", obtained by reproduction in a transferable Vero cell culture inactivated with beta-propiolactone. The vaccine is stored at a temperature of +2 to +8 °C. The KoviVac vaccine prevents COVID-19 in adults aged 18-60.

Nonspecific prevention of Covid-19

Nonspecific prevention is an activity aimed at preventing the spread of infection [24]:

- early diagnosis and active detection of infected, including those with asymptomatic forms;
- compliance with self-isolation; • compliance with a distance of 1.5 to 2 meters;
- the use of social separation measures (temporary termination of the work of public catering enterprises, retail trade (except for trade in essential goods), switching to remote operation, transfer to distance learning of educational organizations;
- use of personal respiratory protection equipment depending on the degree of risk of infection (face shield, disposable medical mask, respirator, insulating half mask, full-face mask);
- carrying out disinfection measures;

General actions with patients diagnosed with coronavirus infection.

Hospitalization of patients (persons with suspected disease) is carried out in boxes, boxed wards or, in their absence, inwards with a gateway and a bathroom, in compliance with the principle of simultaneous (cyclical) filling of wards and taking into account the severity of the patient's condition. Persons with suspected illnesses are recommended to place in single wards. Patients with a confirmed diagnosis can be placed in wards for 2-4 beds, subject to hygienic requirements for the area of wards for one bed in infectious diseases hospitals (at least eight sq. m. m) and the placement of beds at a distance of at least 1.5 - 2 meters from each other. Patients in the presence of staff or other patients should wear medical masks and observe hand hygiene. Patients are not allowed to leave the wards (boxes). However, it is allowed to use mobile communication facilities (in intensive care units,

considering the clinical condition) with their disinfection with alcohol-containing means. Patients with suspected and confirmed infections should be separated (in different wards). If new patients with suspected infection are identified, they can be placed in a ward with other patients with suspected infection. [58]

Information about the districts of the Russian Federation

Currently, there are eight federal districts in the Russian Federation (see Figure 1). – Central (red), Northwestern (light green), Southern (blue), Volga (white), Ural (pink), Siberian (orange), Far Eastern (blue), North Caucasian (blue). The map shows the location of each district. [1]

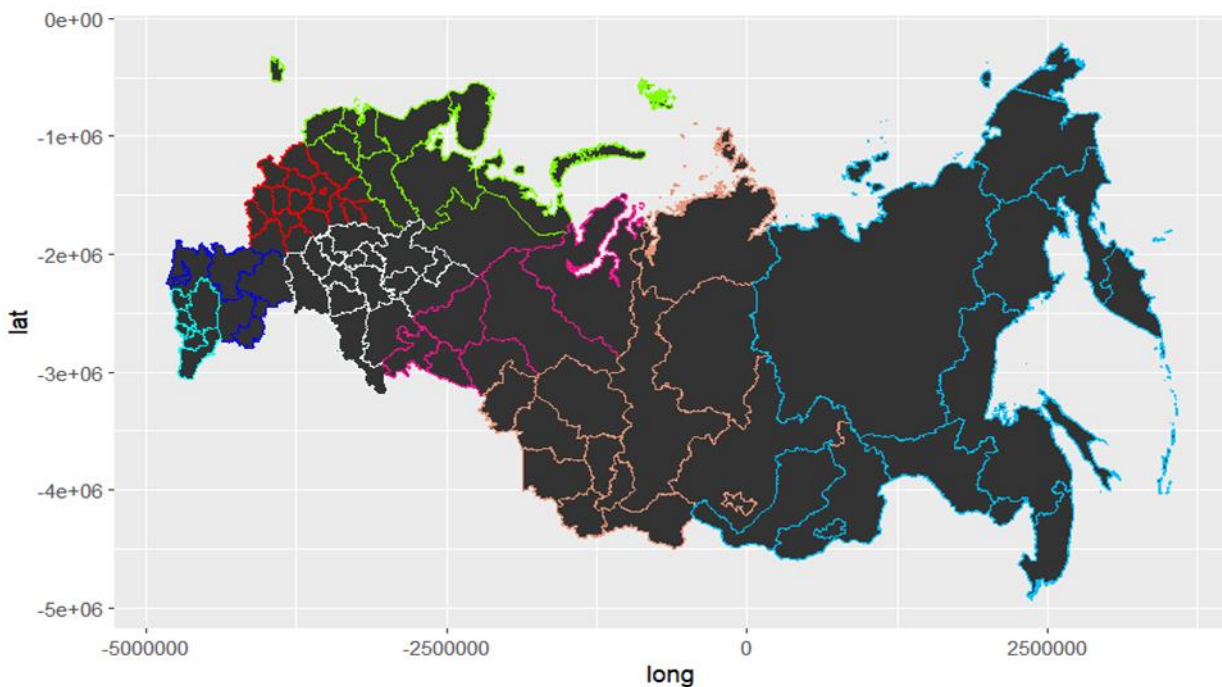


Figure 1 Map of Russia divided into districts

Central Federal District is The Federal District of the Russian Federation in the west of its European part (see Figure 2). The district includes 18 regions (see Figure 3): Belgorod Region, Bryansk Region, Vladimir Region, Voronezh Region, Ivanovo Region, Kaluga Region, Kostroma Region, Kursk region, Lipetsk Region, Moscow Region, Orel region, Ryazan Region, Smolensk Region, Tambov region, Tver region, Tula region, Yaroslavl region, the federal city of Moscow (the Capital). The Central Federal District occupies an area of 650 thousand square kilometres (3.8% of the territory of the Russian Federation) The federal district's population is 39.3 million, which was 26% of the country's total population. The most densely populated region was Moscow (12.6 million) and the Moscow Region (7.7 million).

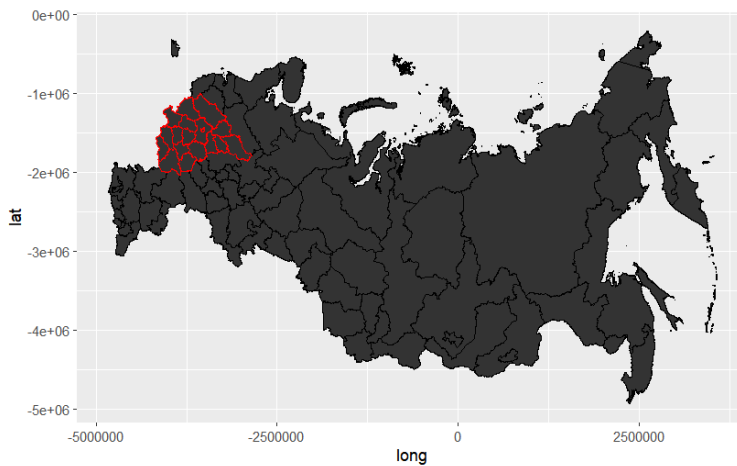


Figure 26CFD district on the map

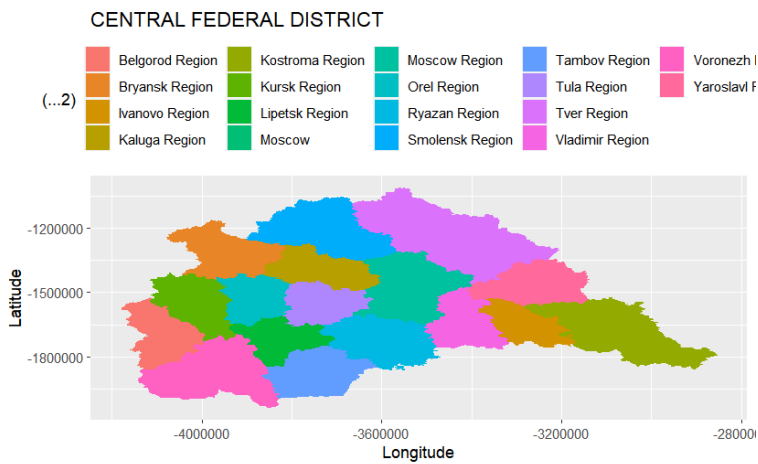


Figure 3List of regions that are part of the district (CFD)

The North-Western Federal District is the federal district of the Russian Federation in the north and northwest of its European part (see Figure 4). The district includes 11 subjects (see Figure 5): The Republic of Karelia, the Komi Republic, the Arkhangelsk Region, the Vologda Region, the Kaliningrad Region, the Leningrad Region, and the Murmansk Region, the Novgorod Region, the Pskov Region, the federal city of St. Petersburg, the Nenets Autonomous Okrug. The NWFD occupies an area of 1,687 thousand square kilometres (9.8% of the territory of the Russian Federation). The federal district's population was 13.9 million, 10% of the country's total population—the most densely populated region was St. Petersburg (5.3 million). The Kaliningrad Region was a semi-enclave of

Russia, as it did not have a common land border with its main territory but was connected to it by the sea.

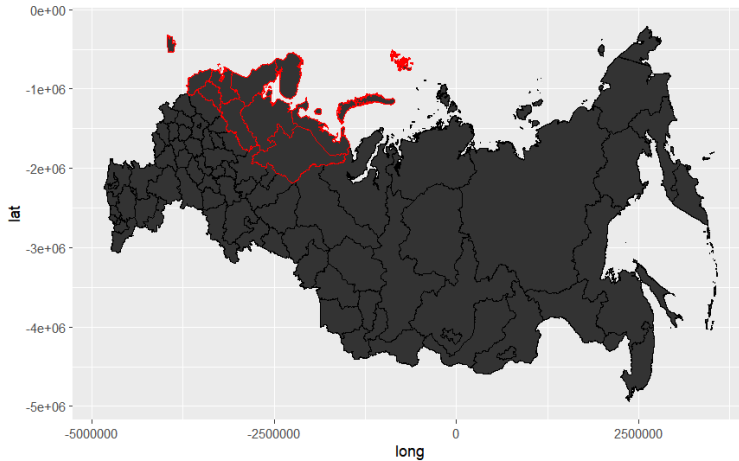


Figure 4NWFD district on the map

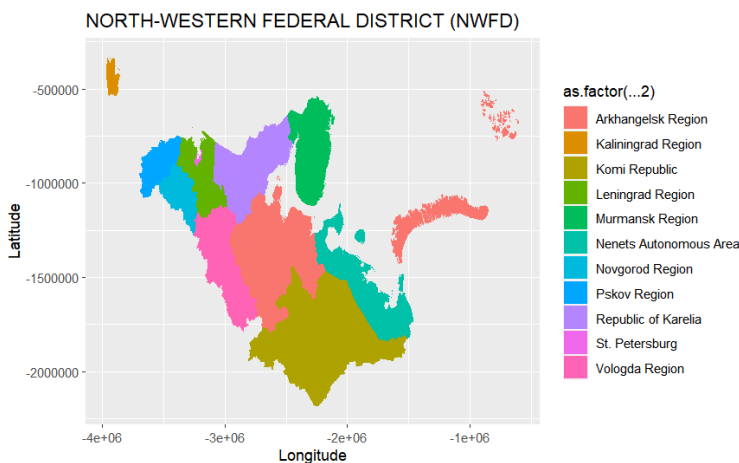


Figure 5List of regions that are part of the district (NWFD)

The Southern Federal District is a federal district of the Russian Federation in the south of its European part (see Figure 6). The district consists of six (eight) subjects (see Figure 7): the Republic of Adygea (Adygea), the Republic of Kalmykia, Krasnodar Krai, Astrakhan Region, Volgograd Region, Rostov Region. SFD occupies an area of 447 thousand square kilometres (2.6% of the territory of the Russian Federation). The federal district's population was 16.4 million, 11% of the country's total population. The most densely populated region was Krasnodar Krai (5.6 million). (until January 2010, the district consisted of 13 subjects of the Russian Federation; in January. 2010 The North Caucasus Federal District was separated from the district; in July 2016, the Republic of Crimea and the federal city of Sevastopol were included in the neighbourhood)

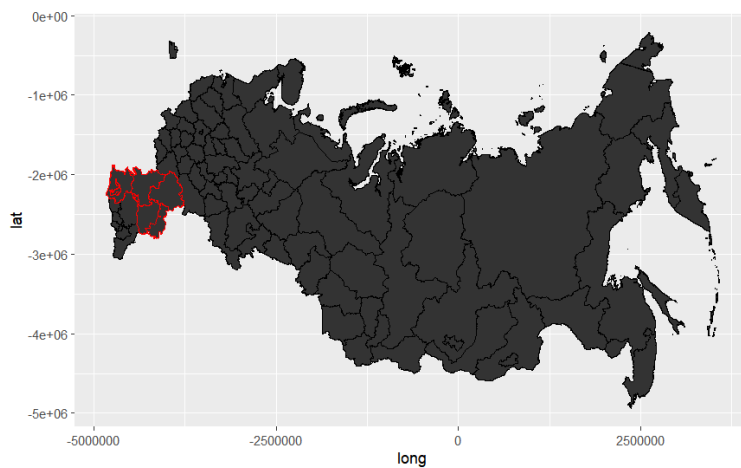


Figure 6 SOUTHERN FD district on the map

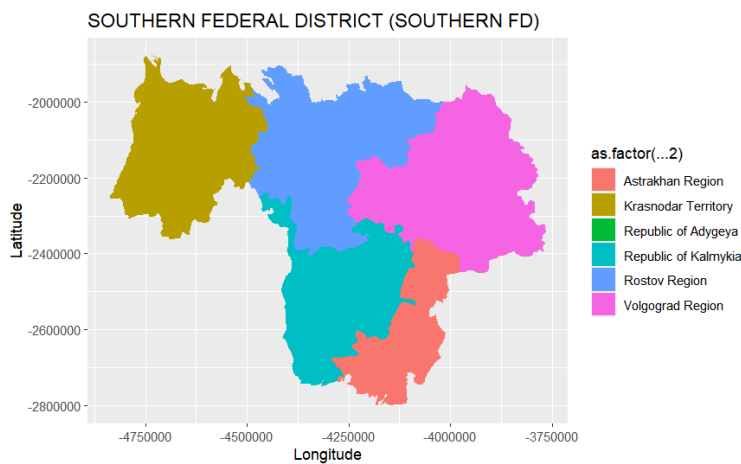


Figure 7 List of regions that are part of the district (SOUTHERN FD)

The North Caucasus Federal District is a federal district of the Russian Federation in the south of the European part of Russia, in the central and eastern part of the North Caucasus (see Figure 8). The district includes seven subjects of the Russian Federation (see Figure 9): the Republic of Dagestan, the Republic of Ingushetia, the Kabardino-Balkaria Republic, the Karachay-Cherkessia Republic, the Republic of North Ossetia–Alania, the Chechen Republic, the Stavropol Territory. The NCFD occupies an area of 170 thousand square kilometres (1% of the territory of the Russian Federation). The federal district's population was 9.9 million, 7% of the country's total population. The most densely populated region was the Republic of Dagestan (3.1 million).

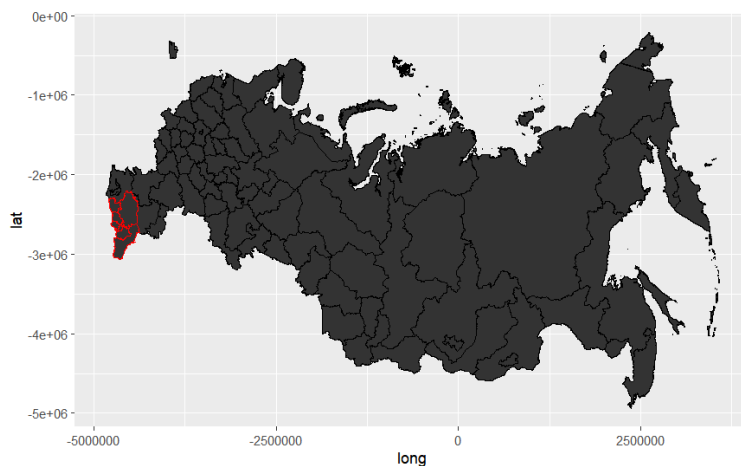


Figure 8 NCFD district on the map

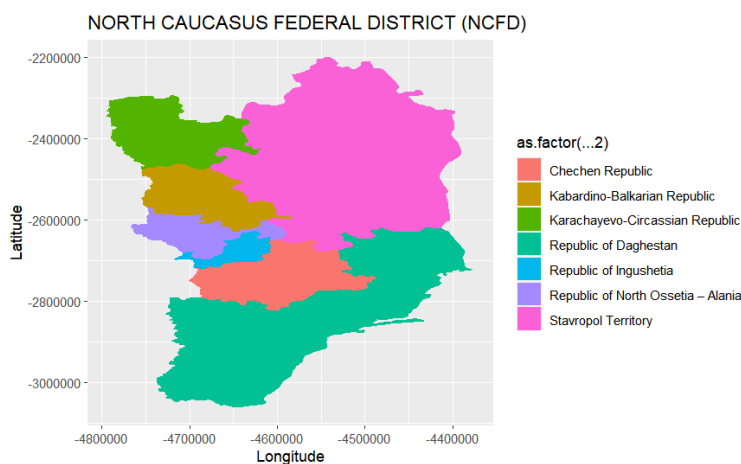


Figure 9 List of regions that are part of the district (NCFD)

The Volga Federal District is a federal district of the Russian Federation located east of the European part of the Russian Federation, the territory of the Urals and the Lower Volga (see Figure 10). The district includes 14 subjects of the Russian Federation (see Figure 11): the Republic of Bashkortostan, the Republic of Mari El, the Republic of Mordovia, the Republic of Tatarstan (Tatarstan), the Udmurt Republic, the Chuvash Republic – Chuvashia, Perm Krai, Kirov Region, Nizhny Novgorod Region, Orenburg Region, Penza Region, Samara Region, Saratov Region, Ulyanovsk Region. The Volga Federal District occupies an area of 1,037 thousand square kilometres (6 % of the territory of the

Russian Federation). The federal district's population was 29 million, which was 20% of the country's total population. The most densely populated region was the Republic of Bashkortostan (4 million).

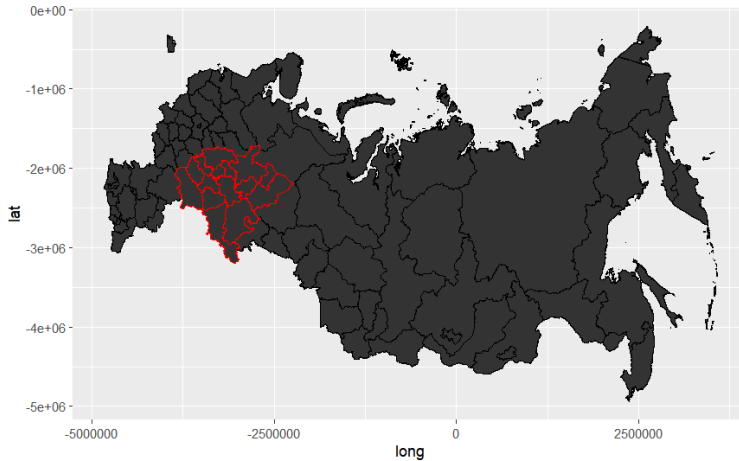


Figure 10 VFD district on the map

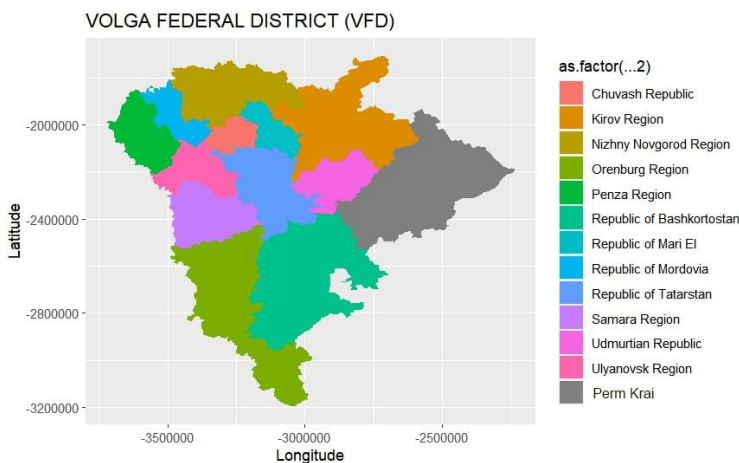


Figure 11 List of regions that are part of the district (VFD)

Ural Federal District was a federal district of the Russian Federation within the Urals and Western Siberia (see Figure 12). The district includes six subjects of the Russian Federation (see Figure 13): Kurgan Region, Sverdlovsk Region, Tyumen Region, Chelyabinsk Region, Khanty-Mansi Autonomous Okrug – Yugra, Yamalo-Nenets Autonomous Okrug. The Ufa occupies an area of 1,818 thousand square kilometres (10.6% of the territory of the Russian Federation). The federal district's population was 12.3 million, 8% of the country's total population. The most densely populated region was the Sverdlovsk Region (4.2 million).

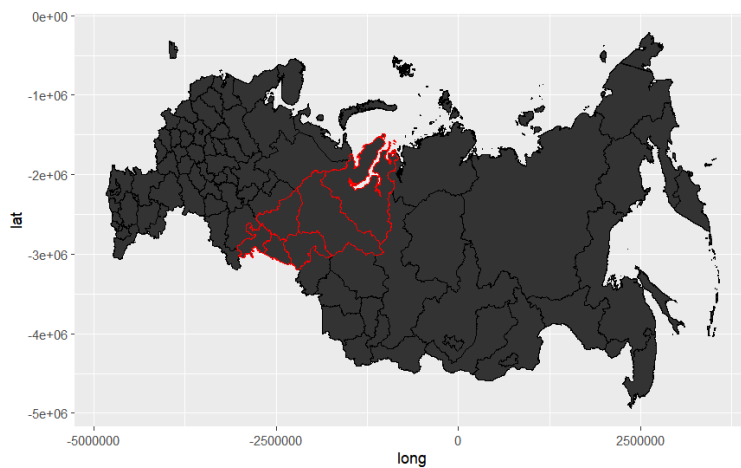


Figure 12 UFA district on the map

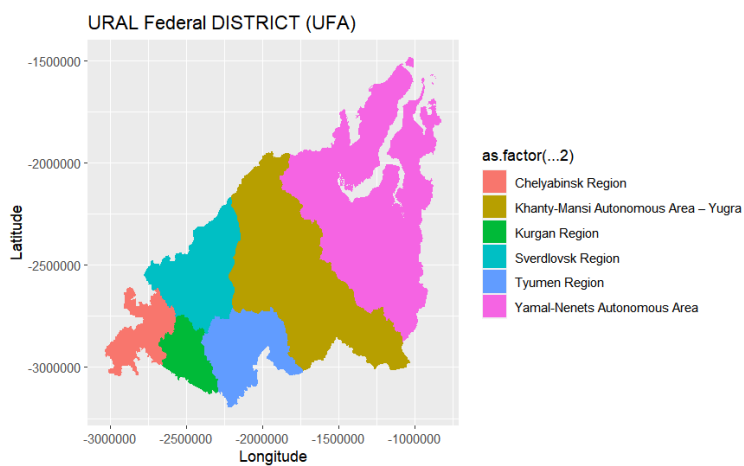


Figure 13 List of regions that are part of the district (UFA)

Siberian Federal District (SFD) was a federal district in the Siberian part of the Russian Federation (see Figure 14). The Republic of Altai, the Republic of Tyva, the Republic of Khakassia, the Altai Territory, the Krasnoyarsk Territory, the Irkutsk Region, the Kemerovo Region – Kuzbass, the Novosibirsk Region, the Omsk Region, the Tomsk Region were located within the district (see Figure 15). The Siberian Federal District occupies an area of 4,361 thousand square kilometres (25.4% of the territory of the Russian Federation). The federal district's population was 17 million, 12% of the

country's total population. The most densely populated region was the Krasnoyarsk Territory (5.6 million).

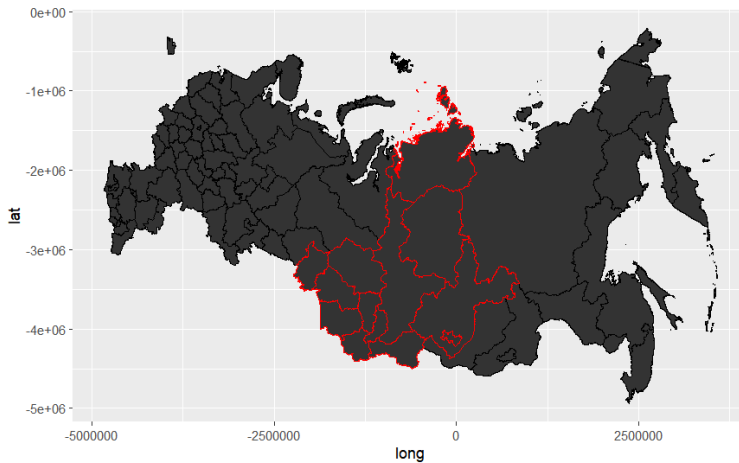


Figure 14 SIBERIAN FD district on the map

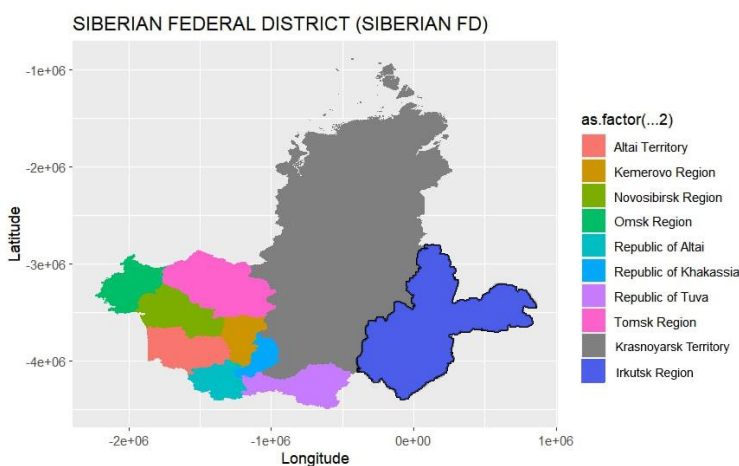


Figure 15 List of regions that are part of the district (SIBERIAN FD)

The Far Eastern Federal District (FEFD) is a federal district of the Russian Federation occupying the territory of the Russian Far East and Eastern Siberia (see Figure 16). There were 11 subjects of the Russian Federation within the district (see Figure 17): the Republic of Buryatia, the Republic of Sakha (Yakutia), the Trans-Baikal Territory, the Kamchatka Territory, the Primorsky Territory, the Khabarovsk Territory, the Amur Region, the Magadan Region, the Sakhalin Region, the Jewish Autonomous Region, the Chukotka Autonomous District. The Far Eastern Federal District occupies an area of 6 952 thousand square kilometres (40.6% of the territory of the Russian Federation). The federal district's population is 8.1 million, 6% of the country's total population. The most densely populated region was Primorsky Krai (1.8 million).

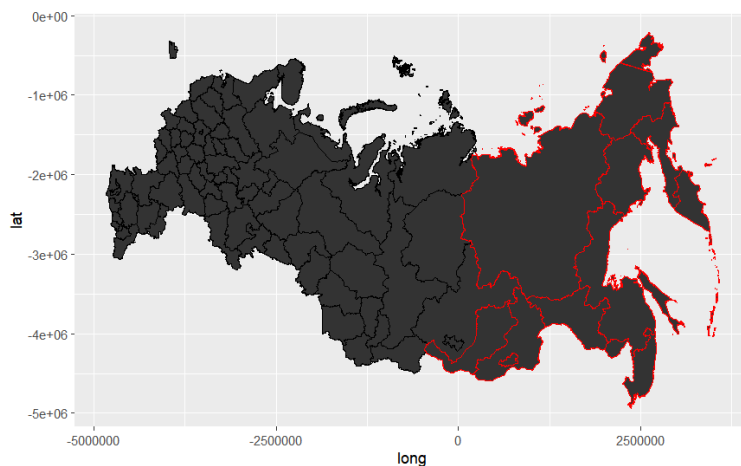


Figure 16 FEFD district on the map

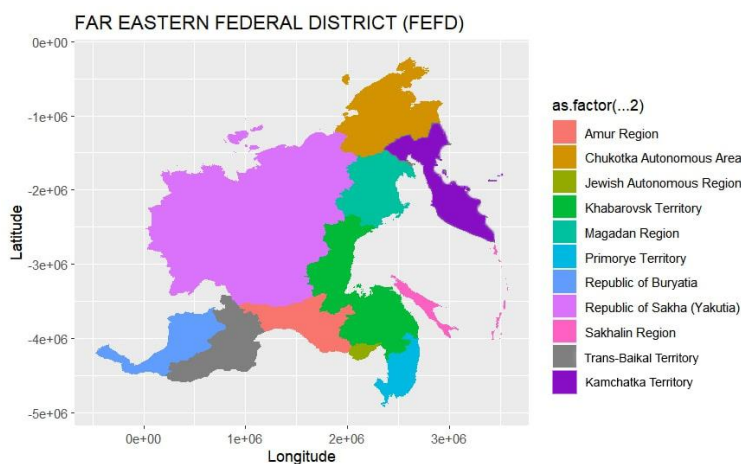


Figure 17 List of regions that are part of the district (FEFD)

Chronology:

This chronology is compiled by analyzing the daily reports of the Communication Center of the Government of the Russian on the situation with coronavirus. The site is an official Internet resource created for information purposes public consultation on coronavirus (COVID-19). [41]

March 2020

- The government was instructed to develop circuitry for the accelerated deployment of additional Covid-19 laboratories.
- Regions will increase the number of infectious diseases beds for patients with Covid-19 infection.
- From midnight on March 27, Russia will stop international flights.
- Airports have organized the screening of all citizens to control Covid-19 infection.
- The Prime Minister called for extending to all regions of the country the restrictive measures already adopted in Moscow and the Moscow region.
- Since Monday, March 30, a home self-isolation regime has been introduced for residents of Moscow and the Moscow region. Moscow authorities have begun calling on residents of the Capital to leave parks and stay at home on "speakerphone".
- The government has allocated 5.2 billion rubles to purchase ambulances in the regions.
- Authorities are tracking more than 730,000 people as part of measures to combat the coronavirus.
- The Ministry of Health decided to attract students from medical universities to help doctors in the fight against Covid-19 infection. (40 thousand people)

<p>April 2020</p> <ul style="list-style-type: none"> • The Ministry of Health has trained over 500 thousand medical workers in safety rules when working with patients with a disease caused by a new Covid-19 infection using webinars. • Moscow is launching a mobile app to monitor coronavirus patients being treated at home. • Based on four clinical hospitals of the University in Moscow, a Covid-19 hospital with 2 thousand beds has been deployed. • Russia will contribute to WHO in the amount of \$ 1 million to fight Covid-19 infection. • Treatment of patients infected with coronavirus is planned in 32 military hospitals. • To combat the coronavirus in the Russian region is planned to deploy 95 thousand beds, including 40 thousand already ready. • The first medical center of the Ministry of Defense to combat the pandemic started operating in Nizhny Novgorod. • The Armed Forces are ready to receive 4,9 thousand of patients in military hospitals. • More than 60 federal clinics in Russia's regions are involved in treating patients with coronavirus; they will deploy an additional 45 thousand beds. • Approximately 16 thousand beds for patients have been deployed in Moscow, and it will be increased to 27 thousand beds. • The Ministry of Defense has started the construction of a medical centre in Voronezh
<p>May 2020</p> <ul style="list-style-type: none"> • Doctors of other specialties, postgraduates, residents and teachers of medical universities will be involved in the fight against coronavirus, the Ministry of Health reported. • In Moscow, health workers are provided with 4 thousand hotel rooms free of charge; 6 thousand are in reserve. • Temporary hospitals to treat those infected with the new Covid-19 infection in Moscow will accommodate 10 thousand beds. • The self-isolation regime in Moscow has been extended until May 31. • Eighty thousand rubles a month for doctors, 50 thousand rubles for average medical staff and ambulance doctors, and 25 thousand rubles for junior medical staff and average junior and ambulance drivers will be paid for performing critical work when helping citizens with Covid -19 infection. • In Moscow, from May 15, mass and free screening for antibodies to COVID-19 will begin. • Sixteen medical centres were built in Russia in two months through the Ministry of Defense. • The Russian Ministry of Health will fully provide Dagestan with funds to fight the coronavirus. • The second batch of additional personal protective equipment for doctors was delivered to Primorye.
<p>June 2020</p> <ul style="list-style-type: none"> • The total number of medical workers has increased almost 2-fold to more than 450 thousand compared with April. • Hospitals will return to providing routine medical care • The government eased restrictions on leaving Russia and entering the country • Specialists of the Russian Ministry of Health will travel to the Amur Region, Karachay-Cherkessia and Kamchatka to help patients with coronavirus in these regions • Specialists of federal institutions The Ministry of Health has already helped fight against coronavirus in 11 regions of the country.
<p>July 2020</p> <ul style="list-style-type: none"> • Completed construction of four medical centres for the treatment of COVID-19 and other diseases in Voronezh and Dagestan • The activity of federal medical institutions in Moscow has been restored, and federal hospitals in other regions are returning to their planned work. • About 6.5 thousand hospital beds remain deployed to receive patients with coronavirus in Moscow.
<p>August 2020</p> <ul style="list-style-type: none"> • The government approved the allocation of funds for deploying an infectious diseases hospital with 360 beds to provide medical care to patients with COVID-19 in Russia. Ivanovo region.
<p>September 2020</p> <ul style="list-style-type: none"> • Since September 27, the Moscow authorities have been resuming the operation of the social service system and support for citizens who must stay at home due to the coronavirus. • The authorities of the Moscow region recommend that employers transfer the maximum number of employees to remote work. • Control over compliance with the mask regime, social distance and other measures will be strengthened for residents of the Moscow region from September 28 • The autumn holidays for schoolchildren in Moscow will be extended to two weeks. They will last from October 5 to October 18.
<p>October 2020</p> <ul style="list-style-type: none"> • More than 200 beds for coronavirus patients will open from Tuesday in a temporary hospital in Patriot Park. • About 300 vehicles are involved in the Moscow region to transport patients with coronavirus.

- About 8.4 thousand infectious beds were deployed in the Moscow region for patients with a new Covid-19 infection.
- About 5 thousand beds for patients with COVID-19 are deployed in St. Petersburg, of which 649 are free.
- In the Russian Federation, 182 thousand beds have been deployed for patients with coronavirus; intensive care beds are filled by 10%.
- An additional 400 beds for coronavirus patients are available at the temporary hospital in Patriot Park in the Moscow region.
- Medical universities are instructed to organize the participation of residents and senior students in the provision of medical care in order to support the health care system.
- In Russia, about 200 thousand beds are deployed for patients with coronavirus.
- Yakutia will provide additional medical facilities and equipment for treating patients with coronavirus.

November 2020

- More than 235 thousand beds for coronavirus patients have been deployed in the regions.
- Regions of the Russian Federation will increase the reserve of beds intended for patients with a new Covid-19 infection to 20%
- Representatives of the Ministry of Health management will arrive in St. Petersburg for organizational support regarding the COVID-19 situation.
- Specialists of the Ministry of Health are sent to the Republic of Khakassia. They will check the provision of medical care to the population.
- The authorities of the Moscow region plan to introduce new restrictive measures for residents over 65 years of age from November 11. In particular, block social cards.
- Restaurants and clubs in Moscow will not serve customers during the period from 23: 00 to 06: 00. The restriction is introduced from November 13 to January 15, 2021
- Universities in Moscow and St. Petersburg are moving to distance learning.
- A mobile military hospital for COVID19 patients has been deployed in Chernogorsk in Khakassia.
- About 272 thousand beds for patients with coronavirus are deployed in Russia. On average, 20% of them are free.
- The Defense Ministry has built more than two dozen new medical centres this year.
- Additional 12 computed tomography centres are opening in Moscow due to the growing incidence of COVID-19.

December 2020

- New restrictive measures in connection with the spread of Covid-19 infection come into force on the territory of St. Petersburg.
- The intensive care unit of the reserve hospital for patients with a new Covid-19 infection has opened in the Capital in Pavilion No. 75 of VDNH.
- Four hundred sixty-nine telemedicine centres for consultations of patients with Covid-19 infection have been deployed in Russia.
- More than 7 thousand volunteers in Russia help 765 medical organizations as part of the all-Russian campaign "We are together".
- Thirty-three thousand intensive care beds for patients with coronavirus have been deployed in the Russian Federation.
- More than 8 thousand beds are deployed in military medical institutions to treat those infected with Covid -19 infections. Half of them are used for civilians.
- On December 22, for a week, Russia stopped air traffic with the UK due to the deterioration of the epidemiological situation.

Timeline of the 2020 pandemic

January 2021

- Extension of the suspension period of flights to the United Kingdom has been extended.
- In the country, 277 thousand intensive care units are deployed, the average occupancy of beds is 69.2%, 7.6 thousand beds are free, and 31 thousand intensive care beds.
- January 18 was announced as the start date of mass vaccination against coronavirus in Russia.
- More than 600 thousand medical workers and over 24 thousand volunteers were helping.
- In Moscow, restrictions on the night (from 23:00 to 06:00) work of public catering enterprises, nightclubs, bars, discos, and karaoke have been lifted.
- The children's building of the new infectious disease hospital, built by the Ministry of Defense on behalf of the President of Russia, opened in the Pskov region.

February 2021

- In Moscow, two hospitals for 2 thousand patients will be returned to the planned reception of patients.

March 2021

- Russia extends the suspension of air traffic with the United Kingdom until April 16.
- St. Petersburg's ban on holding public events has been extended until April 30.

<ul style="list-style-type: none"> • More than 130 thousand hospital beds for patients with coronavirus are now deployed in Russia
April 2021 <ul style="list-style-type: none"> • One hundred fifteen thousand beds were deployed for the treatment of patients, and a sufficient number of reserve beds – 15%. • Two thousand four hundred twenty medical organizations of all forms of ownership, including federal and private ones, are involved in treating COVID-19 patients.
May 2021 <ul style="list-style-type: none"> • In St. Petersburg, 5,992 beds are deployed, of which 1,176 are available (19.6%). • In Mari El, restrictions were extended due to coronavirus until July 5.
June 2021 <ul style="list-style-type: none"> • In Moscow, due to the increase in the incidence of COVID-19, June 15-19 was declared a non-working day. • Moscow has provided more than 350 artificial ventilation devices, more than 450,000 copies of medicines and more than 6,000 medical beds to the regions of the Russian Federation during the pandemic. • Three hospitals in the Kursk region suspended planned hospitalization due to the deterioration of the situation with Covid-19 infection. • A limit on entertainment events is being introduced in the Capital – a maximum of one thousand people can attend. • Moscow is increasing its capacity to diagnose COVID-19, and an additional five CT centres have been opened, bringing the total number to 35. • The Patriot temporary Hospital in the Moscow Region has resumed its work. • The recommendation to transfer at least 30% of employees to remote work in Moscow remains unchanged. • Moscow will deploy 22.5 thousand beds for patients with coronavirus. The Capital's capacity is 24 thousand beds. • We have increased the number of beds in the Kamchatka Territory-120 additional beds in three medical institutions. • Measures are being taken to ensure the necessary supply of oxygen in hospitals. • Tuva authorities are returning part of the restrictions to the republic to prevent the spread of Covid-19 infection. • The authorities of Buryatia introduce strict restrictive measures in the republic from June 27 to July 11 • Russian Defense Ministry to deploy field hospital in Tula region • More than 182 thousand hospital beds are deployed in Russia for patients with coronavirus, while 151 thousand people are currently hospitalized.
July 2021 <ul style="list-style-type: none"> • Entertainment and catering services at night are prohibited in 69 regions. Additionally, stricter restrictions in connection with the coronavirus were introduced in the following regions: in the Angara Region until July 18, in the Mari Republic, in Kaliningrad, In Transbaikalia until August 6, in Tomsk Region from July 12, Kamchatka from July 15, Sakhalin and Kuril Islands, Sakhalin and Kuril Islands, Yakutia, Leningrad Region until August 15, St. Petersburg until August 29 • Just over 216k units deployed. Covid beds, of which more than 146 thousand are equipped with oxygen, and more than 26 thousand are equipped with artificial ventilation devices • The authorities of the Moscow region have already deployed 14.5 thousand beds for patients with Covid-19 infection. In total, 20% of the region's Covid-19 bed stock is now available. • A 700-bed hospital is being opened in Irkutsk. • Anesthesiologists from different regions of Russia arrived in Buryatia to help treat patients with COVID-19. • On Eid al-Adha, Moscow mosques will be closed to parishioners. Instead, the celebration will be held in an online format. • The authorities of Kabardino-Balkaria, due to the growing incidence of coronavirus, opened a new third hospital for patients with COVID-19 based on one of the city hospitals in Nalchik. • Employers in Yakutia were obliged to remove unvaccinated employees from August. • Russian Defense Ministry aviation has transferred a mobile military hospital with 100 beds to Khakassia to treat COVID-19 patients. • Beds of the second reserve for patients with coronavirus are deployed in the Jewish Autonomous Region, and hospitals are 85% full. • Moscow region authorities will close a temporary hospital for patients with Covid-19 infection in Patriot Park on August 1. • Northern Infectious Diseases Hospital for Coronavirus patients with 200 beds opened in Karachay Cherkessia. • The mandatory requirement to wear gloves in public places has been abolished in Moscow. • Eighty intensive care units in covid-19 hospitals will be equipped in the Altai Territory, for which more than 200 million rubles were allocated from the regional budget
August 2021 <ul style="list-style-type: none"> • The workload in the Astrakhan region's Covid-19 hospitals is 90% • A mobile hospital of the Russian Defense Ministry will be opened in North Ossetia.

- The authorities of the Kemerovo region extended the high-alert regime
- The number of beds in the Saratov region exceeded 3.1 thousand, while the free bed stock is slightly more than 11%.
- Additional restrictions due to COVID-19 will be introduced in three districts of Chuvashia, in the Tyumen Region until September 1 (a moratorium on mass events until September 30)
- An additional hospital for children with coronavirus is being deployed in Yakutsk.
- Specialists of the Federal State Budgetary Institution, "412 Military Hospital" in Vladikavkaz, will be involved in treating patients with coronavirus.
- Additional special equipment for the transportation of medical oxygen due to the increase in the number of coronavirus infections will be purchased in Dagestan.

September 2021

- In the Leningrad region, 115 beds were deployed for patients with coronavirus. More than 30 classrooms in 19 schools are closed due to the coronavirus. In Ugra, the bed fund for patients with COVID-19 increased by almost 12% in two weeks. About 150 classes were transferred to distance learning.
- Restrictive measures in connection with the coronavirus pandemic have been extended until the end of October in St. Petersburg, in Kalmykia until October 24, in Chuvashia and the Lipetsk Region.
- Additional 500 beds in the Saratov region due to an increase in the number of cases of COVID-19.
- High alert mode due to coronavirus extended until October 31 in the Penza Region, in the Yamalo-Nenets Autonomous District.
- The bed capacity in the Irkutsk and Rostov regions is increasing due to the number of patients with COVID-19.
- In Vladivostok, 17 school classes were quarantined due to the coronavirus.
- The number of places for patients with COVID-19 has increased in the Voronezh Region. As a result, there are 5,578 beds in total.

October 2021

- Mass events across the country in connection with the pandemic have been cancelled.
- Restricted access regime due to the spread of Covid-19 in Yakutia, Ingushetia, Pskov Region, Penza Region, Khakassia, Tomsk Region, Khabarovsk Krai,
- Additional Covid-19 hospitals/locations opened due to rising incidence in Mordovia (17 hospitals, the number of beds increased to 2.7 thousand), and In the Voronezh Region increased by 20%(an additional hospital was created based on the gerontology centre in Voronezh), in the Komi Republic (115 beds), in St. Petersburg (400 beds), in Karachay-Cherkessia (120 beds), the Chelyabinsk region (150 beds), Moscow region (400 beds), the fifth hospital opened in Kabardino-Balkaria, Altai Krai, Kursk, Blagoveshchensk (100 beds),
- The operation of the mask regime in the Jewish Autonomous Region was extended until October 29.
- The workload of the bed fund for the treatment of patients with coronavirus in the Pskov region, where the authorities do not rule out the introduction of lockdown, increased to 90%.
- 235 thousand beds have been deployed for coronavirus patients, 212 thousand patients are in hospitals,
- In North Ossetia, 116 classes and six groups in kindergartens were closed due to coronavirus
- In Vladivostok, 17 classes in 11 schools were transferred to remote learning due to the coronavirus.
- Ulyanovsk authorities have purchased about 200 oxygen concentrators for hospitals.
- From 11 to October 24, the Saratov region's authorities introduced a ban on smoking hookahs in public places at night.
- In the Magadan region, extended the high alert mode.
- In Russia, the days from October 30 to November 7 are declared non-working, with employees ' salaries being preserved.
- Non-working days in Moscow and the Moscow Region are set from October 28 to November 7, 2021
- In Moscow, a home regime for elderly and chronically ill residents began to operate.
- A group of 35 military medics arrived in Moscow to help doctors in Covid-19 hospitals in the Tula region, according to the press service of the Ministry of Health of the Russian Federation.
- The Russian Defense Ministry sends medical teams from three regions to Khakassia to help fight COVID19.
- Five CT centres for patients with COVID-19 have resumed their work in Moscow. In addition, free express testing points have been opened at five Moscow Metro stations.
- High-alert mode extended until the end of December in the Novosibirsk region

November 2021

- Covid-19 hospital for 75 beds opened in Tomsk due to the growing incidence in the region.
- The Russian Defense Ministry has sent over 100 military medics to the Tula region to help fight Covid-19.
- In Kamchatka, an additional 40 beds were deployed to combat the coronavirus. The total number of beds currently stands at 310
- The first 50 beds for children with coronavirus were deployed in the Vologda region.
- In Omsk, a gynaecological hospital will be converted for patients with Covid-19.
- More than 200 medical students were involved in the fight against COVID-19 in medical institutions in Primorye.

- In Chita, the department of the perinatal centre allocated 130 Covid-19 beds.
- In total, 301.5 thousand Covid-19 beds are deployed in the country, and 201 thousand are equipped with oxygen supply. Currently, 82.8% of beds for those infected with coronavirus are occupied.
- Twelve regions of Russia have introduced mandatory vaccination for residents over 60%: St. Petersburg, Krasnodar, Stavropol and Perm Territories, the Republic of Bashkortostan, Irkutsk, Belgorod, Amur and Kaluga regions, Khanty-Mansiysk and the Nenets Autonomous Okrug.
- The Russian Ministry of Health sent a team to the Volgograd region to help in the fight against COVID-19.

December 2021

- Since December 2, Russia has imposed a 14-day quarantine for arrivals from the Republic of South Africa and neighbouring countries.
- Military doctors of the Central Military District have completed the care of more than 3 thousand patients with Covid-19 in the Republic of Khakassia.
- Observation beds for patients with the omicron coronavirus strain were opened in Nizhny Novgorod.
- Military medics helped fight against coronavirus to 1.5 thousand residents of the Pskov region.
- The high alert mode due to the coronavirus was extended in the Penza Region until February.
- Novosibirsk authorities have introduced additional restrictions due to a new Covid-19 infection.
- In coronavirus hospitals, 183,000 beds remain re-designated for patients with COVID-19.
- More than 78 million people in the Russian Federation have been vaccinated with the first dose of the coronavirus vaccine.
- About 67% of senior citizens of the Russian Federation were vaccinated against Covid-19.
- About 28% of Covid-19 patient beds are on standby.
- Every fifth region of Russia has relaxed restrictions on public catering on the eve of the New Year.

2Timeline of the 2021 pandemic

Aims and Research Question

One of the main problems in assessing the impact of a pandemic on a country's population is the collection and evaluation of data. Various researchers have tried to determine and understand the causal relationship between the impact of the pandemic and mortality. Studies of other countries have shown the importance of such an indicator as mortality from all causes. The primary aim of this thesis is to describe death from all causes in Russia during the two years of the Covid-19 pandemic. In addition, it examines the expected mortality from all causes based on the previous fifteen years. Furthermore, support and anti-epidemic measures created by the government were described and analyzed. The following paper describes the study and analysis of preliminary data obtained due to a two-year pandemic.

Methods

Data source

The data of our study combined information from several sources. First, we took publicly available information from the Federal State Statistics Service [9], Rosstat [10], which officially publishes reports based on the "Principles and Recommendations for the System of Statistical Accounting of Natural Population Movement" developed by the United Nations [32]. The publicly available Rosstat data we used is stored on the official website. We have extracted monthly information for each region. The data contain The number of registered deaths (operational data) (person), the number of

registered births (operational data), the number of permanent population on average per year, Migration arrivals, Migration departures, and the total increase in the permanent population, the incidence of the population by significant classes of diseases in 2000 - 2020, Deaths by the main classes of causes of death, The number of secondary medical personnel (individuals) in organizations providing medical services, the number of hospital beds, at the end of the year, the number of stations (departments) of emergency medical care (at the end of the year), the Directory "subjects of the Russian Federation". All data were obtained from 2006-2021.

For the second one, we used data from an official news source - Stopcoronavirus. [41] The Russian Federation is the official Internet resource for informing the public about coronavirus (COVID-19). From it, we extracted information about daily reports on the spread of coronavirus in the country with a detailed description: Total confirmed cases of the disease / Number of tests (thousand tests), the number of patients under the supervision of doctors, government measures. Also, thanks to this resource, the data "Dynamics by region, increase per day of infections" were obtained. Based on these data, a daily chronology of Russia's pandemic (COVID-19) was created. The chronology of events compiled correctly and in detail allows for a more accurate and correct description of the pandemic, using such a tool as mortality from all causes.

All data were combined in one table excel and prepared for the analysis of the imputation missing data (for some region there was data from some months missing). The average value in the regions of the current year was used for imputation. The data were stratified by counties that contain regions. The region "Crimea", "Sevastopol", and the Baikonur spaceport were excluded from the data set due to insufficient data. The Nenets Autonomous Okrug was incorporated into the Arkhangelsk Region, both a subject of the Russian Federation and an integral part of the region.

Statistical analysis

Our goal is describe the mortality during the pandemic yeas 2020 and 2021. For this, we predicted. the expected mortality that we would have observed in the absence of a pandemic in 2020-2021.[37] In order to do so, we use three linear regression models: the first model estimates the number of deaths in each region separately, the second model estimates the number of deaths in the district, and the third model contains the country's data.[19] (see a summary of the regression results in the Appendix) For internal validation, data from 2006 to 2018 were used to predict the expected mortality in 2019 and compared to the already observed mortality. As independent variables, we used months, number of births, the average population per year and migration. To compare the predictive effectiveness of

the models, we will use two measures: the mean absolute error of the forecast (MAE) and the standard error of the estimates (MSE). MAE calculates the mistake on the same scale as the data. This is usually easier to interpret the wrongly predicted death. Each region was analyzed using descriptive statistics, stratified by districts and presented as a summary table. [42]

Aggregated data from the civil registration system on births and deaths are available online. Each data set has a passport that includes the validity period of the data, the length of the time series, the last update, comments and the responsible person. The resulting data is publicly available, aggregated and anonymous, so an ethics vote is not required. The data obtained do not allow us to conclude any specific individuals. The analyses were carried out using R version 3.6.0, and RStudio requires R 3.3.0. Data accumulation was carried out in Excel.

Results

RUSSIAN FEDERATION (RF)

From 2006 to 2019, 27,204,941 people died from all causes in Russia. Splitting down into years, we observe 2,165,742 (8%) in 2006; 2,080,068 (8%) in 2007; 2,080,962 (8%) in 2008; 2,013,590 (7%) was in 2009; 2,030,963 (7%) in 2010; 1,925,036 (7%) in 2011; 1,898,836 (7%) in 2012; 1,878,269 (7%) in 2013; 1,879,305 (7%) in 2014; 1,911,413 (7%) in 2015; 1,887,913 (7%) in 2016; 1,824,340 (7%) in 2017; 1,827,827 (7%) in 2018; 1,800,677 (7%) was in 2019. The data indicate an annual decrease in all cases of deaths by 1% from all causes in Russia since 2006. The map demonstrates the mortality rate from all causes in the country per 100,000 people in 2020 (see Figure 18) and 2021 (see Figure 19). We saw a predominantly high mortality rate in the European part of the country, with mortality considerably decreasing when moving eastward. There is also a low mortality rate in the North Caucasus District. (the map was created using R statistical software).

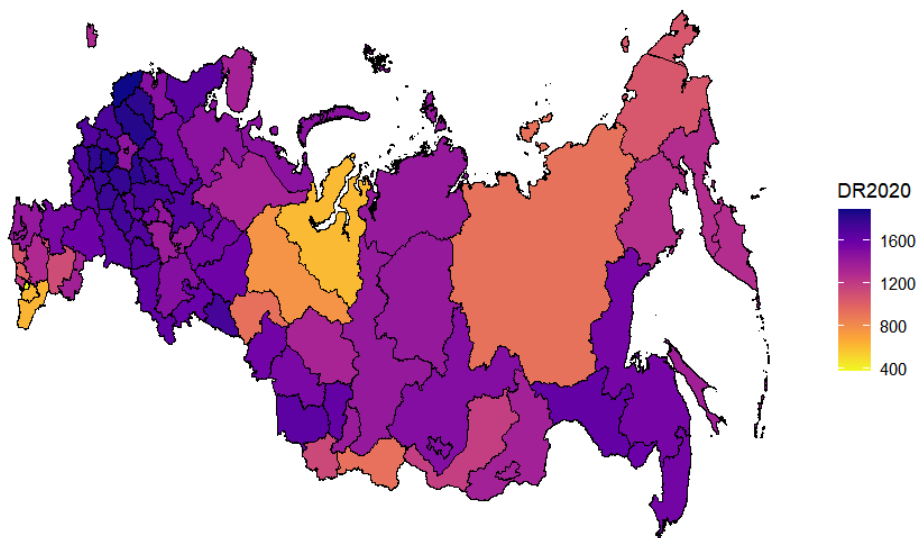


Figure 18 Mortality map in Russia in 2020

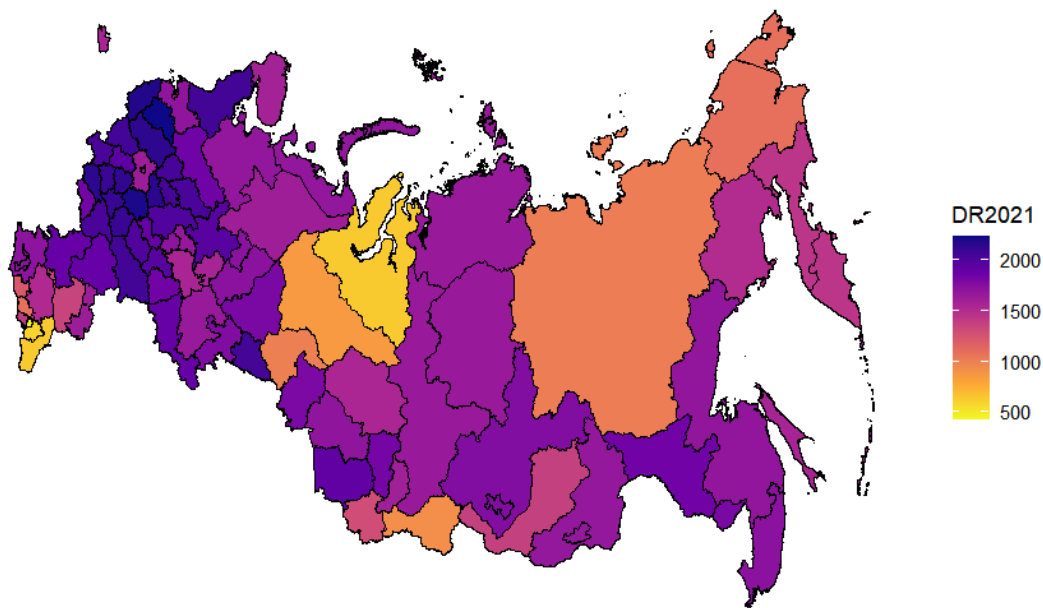


Figure 19 Mortality map in Russia in 2021

Considers all cases of deaths in 2020 in Russia, taking into account data for previous years (see Figure 20). The average monthly mortality in 2020 was 120(107-134) per 100,000 people, corresponding to 2007-2008. The peak at the end of the year was at 243235 (166 per 100,000), the maximum number of deaths. The corresponding for 2019 was 102 per 100,000 people. Based on previous years, the expected number of deaths was considerably lower (1,702,400); thus, the observed number of all cases of deaths was 26% higher than expected. In 2021 (see Figure 21), we marked the apex average

monthly mortality for the last 15 years, 139 (1206-152) per 100,000 people. The peak falls during the previous two months at 257292 (176 per 100,000), the highest value for the 2 studied years. Therefore, in 2021 all cases of deaths were 46% higher than expected (1,690,102). The actual data used for constructing graphs and maps in the form of a summary table are attached (see Appendix).

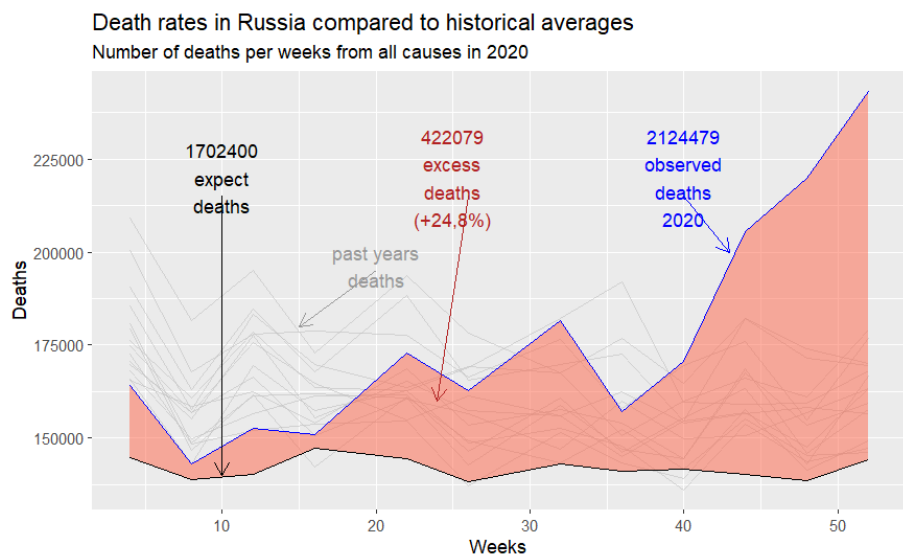


Figure 20 Number of deaths per weeks from all causes in RF in 2020

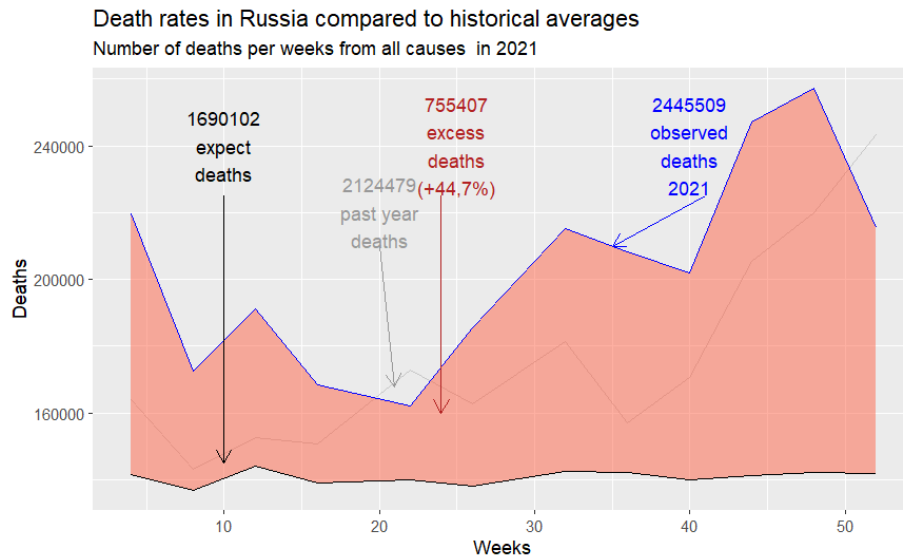


Figure 21 Number of deaths per weeks from all causes in RF in 2021

CENTRAL FEDERAL DISTRICT (CFD)

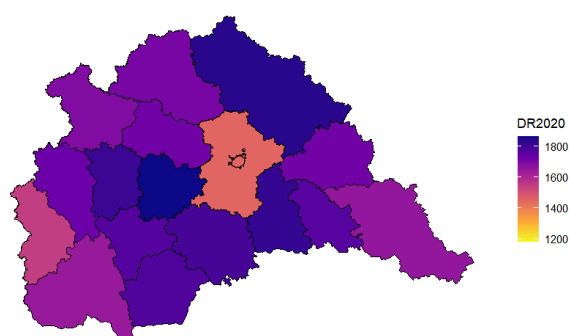


Figure 22 Mortality map in CFD in 2020

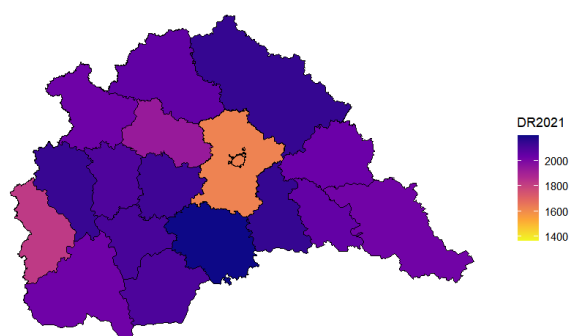


Figure 23 Mortality map in CFD in 2021

From 2006 to 2019, 7,676,141 people died from all causes in the Central Federal District. Splitting down into years, we observe 620,293 (8.1%) in 2006; 599,174 (7.8%) in 2007; 598,830 (7.8%) in 2009; 575,620 (7.5%) in 2009; 584,555 (7.6%) in 2010; 536,093 (7%) in 2011; 536,160 (7%) in 2012; 530,314 (6.9%) in 2013; 530,211 (6.9%) in 2014; 526,751 (6.9%) in 2015; 526,159 (6.9%) in 2016; 506,309 (6.6%) in 2017; 507,771 (6.6%) in 2018; 497,901 (6.5%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 1.5%. We noted that the highest mortality rate before the pandemic was in Moscow and the Moscow region. In other regions, there went down. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 22) and 2021 (see Figure 23). We saw a predominantly high mortality rate in the periphery of the district. Chart all-cause deaths were considered by taking into account data from previous years in the Central Federal District was taken into account taking into account data for previous years. The average monthly mortality in 2020 was 125 (111-138) per 100,000 people, equaling 2009 (see Figure 24). As evident from the graph, the peak was noted at the end of the year at 67,568 (171 per 100,000), the maximum number of deaths. The corresponding for 2019 was 111 per 100,000 people. Based on previous years, the expected number of deaths was considerably lower (449,131); thus, all cases of

deaths were 31.5% higher than expected. In 2021 (see Figure 25)., we pointed out the highest average monthly mortality for the last 15 years, 145(132-158) per 100,000 people. The peak also falls in the previous two months at 72,859 (185 per 100,000), the apex value for the two studied years. Therefore, in 2021, all cases of deaths were 52% higher than expected (449,723).

In 2020, we saw the lowest number of average monthly deaths in the district in two regions: in Moscow, 98 (87-109) and the Moscow region, 121 (107-134) per 100,000 people. At the same time, the highest number of deaths were registered in these regions: 16,546 (Moscow) and 12,991 (Moscow region). However, the expected all cases of deaths in the Capital were lower than observed. While in 2021, it was 11% higher than expected (155,200). Moscow and the Moscow Region retain the leadership in the number of deaths (17,334 and 12,817) while maintaining the lowest number of average monthly deaths, 113(104-123) and 135 (123-147). The region with the lowest number of deaths in 2021-2021 was the Kostroma Region (10,463-12,614), with an average monthly mortality of 138 (123-152) in 2020 and 168 (144-191) in 2021. The actual data and additional graphs for each region used for plotting charts and maps in the form of a summary table are attached (see Appendix)

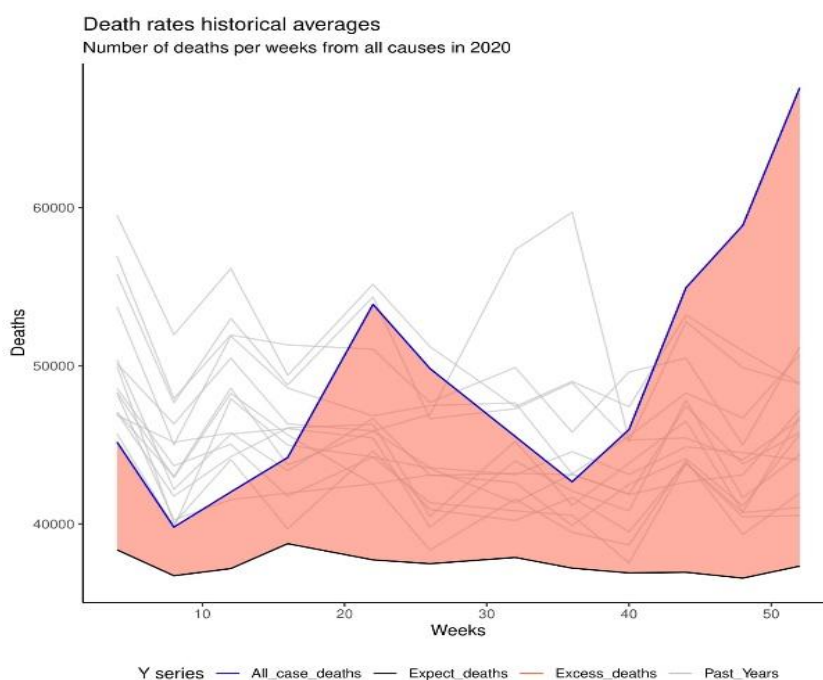


Figure 24 Number of deaths per weeks from all causes in CFD in 2020

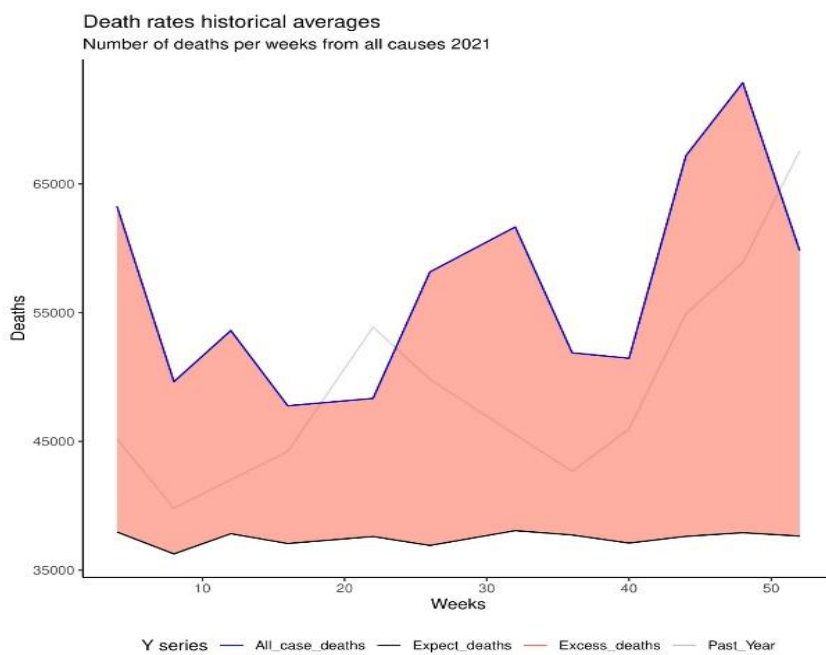


Figure 25 Number of deaths per weeks from all causes in CFD in 2021

NORTH-WESTERN FEDERAL DISTRICT (NWFD)

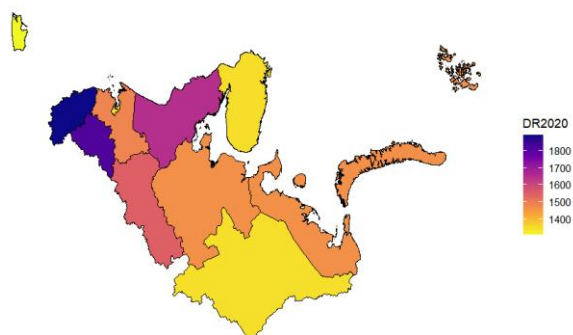


Figure 26 Mortality map in NWFD in 2020

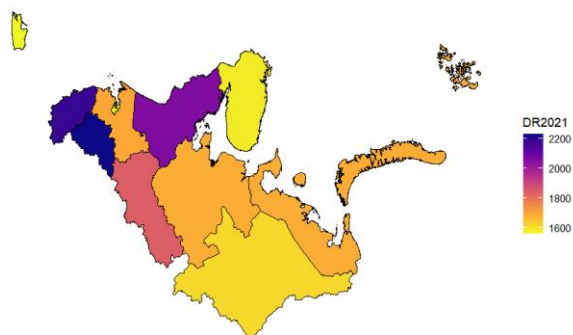


Figure 27 Mortality map in NWFD in 2021

From 2006 to 2019, 2,697,526 people died from all causes in the North-Western Federal District. Splitting down into years, we observe 225,850 (8.4%) in 2006; 211,314 (7.8%) in 2007; 211,696 (7.8%) in 2008; 204,680 (7.6%) in 2009; 203,066 (7.5%) in 2010; 189,587 (7%) in 2011; 187,809 (7%) in 2012; 184,482 (6.8%) in 2013; 183,810 (6.8%) in 2014; 185,103 (6.9%) in 2015; 183,026 (6.8%) in 2016; 177,894 (6.6%) in 2017; 175,797 (6.5%) in 2018; 173,412 (6.4%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 2%. We noted that the highest all cases of deaths rate before the pandemic was in St. Petersburg and the Leningrad region, decreasing yearly. Since 2014, all cases of deaths from all causes have been increasing in the Arkhangelsk region. In other regions, there went down. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 26) and 2021 (see Figure 27). We saw a predominantly high mortality rate in the northwestern part of the district. Chart all-cause deaths were considered by taking into account data from previous years in the North-Western Federal was taken into account taking into account data for previous years. The average monthly mortality in 2020 was 120(108-132) per 100,000 people, corresponding to 2010 (see Figure 28). As evident from the graph, the peak marked at the end of the year was at 24066 (172 per 100,000); this was the top value for the two studied years. The corresponding for 2019 was 103 per 100,000 people. Based on previous years, the expected number of deaths was considerably lower (159,758); thus, all cases of deaths were 26.5% higher than expected. In 2021 (see Figure 29), we marked the highest average monthly mortality for the last 15 years, 141(130-152) per 100,000 people. Also, the apex value falls in the first month at 23,030 (165 per 100,000). Therefore, in 2021 all cases of deaths were 49% higher than expected (158,117).

In 2020, we saw the lowest number of average monthly deaths in the district in three regions: the Komi Republic 111 (97-126), the Murmansk Region 112 (100-124) and St. Petersburg 112 (100-124) per 100,000 people. At the same time, St. Petersburg recorded the highest number of deaths in 2020 -72,750 and in 2021 – 84,196; where all expected deaths were lower than those observed by 14% (63,839), increasing in 2021 to 33% (63,106). In addition, the average monthly mortality at 130 (118-142) per 100,000 people rose, which was minimal compared to the rest. The region with the lowest number of deaths in 2021-2021 was the Murmansk Region (9,929-11,548), with an average monthly mortality at 112 (100-124) in 2020 and 132 (119-144) in 2021. The actual data and additional graphs for each region used for plotting charts and maps in the form of a summary table are attached (see Appendix).

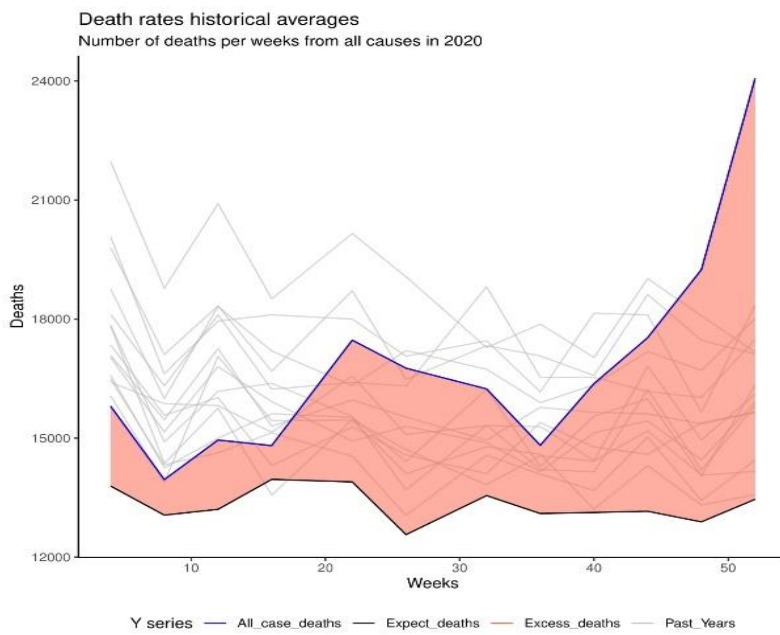


Figure 28 Number of deaths per weeks from all causes in NWFD 2020

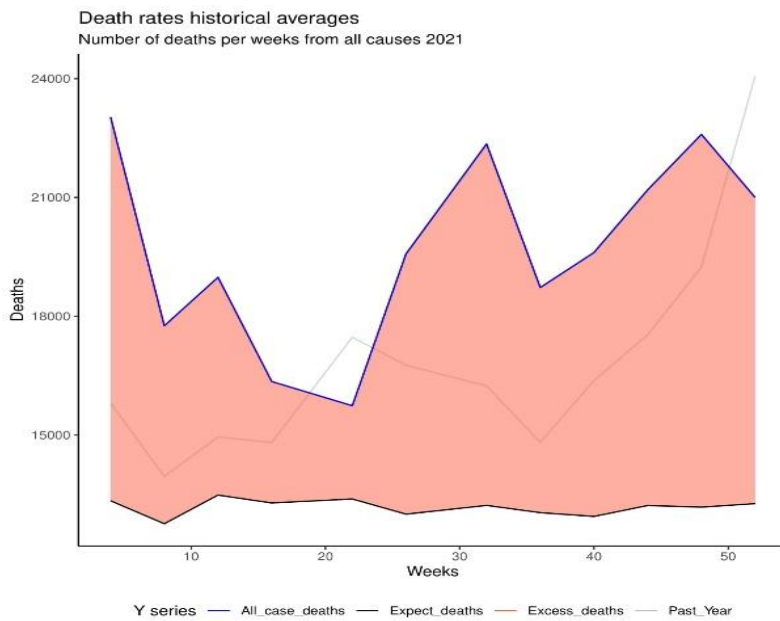


Figure 29 Number of deaths per weeks from all causes in NWFD 2021

SOUTHERN FEDERAL DISTRICT (SOUTHERN FD)



Figure 30 Mortality map in SOUTHERN FD in 2020

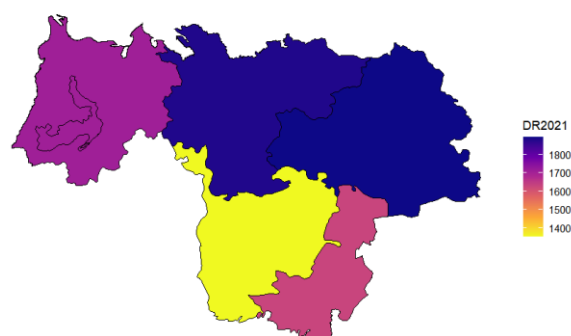


Figure 31 Mortality map in SOUTHERN FD in 2021

From 2006 to 2019, 3,065,353 people died from all causes in the Southern Federal District. Splitting in the year, we observe 289,945 (9.5%) in 2006; 278,977 (9.1%) in 2007; 277,913 (9.1%) in 2008; 275,764 (9%) in 2009; 195,140 (6.4%) in 2010; 189,689 (6.2%) in 2011; 185,379 (6%) in 2012; 183,319 (6%) in 2013; 186,809 (6.1%) in 2014; 186,625 (6.1%) in 2015; 185,351 (6.0%) in 2016; 208,001 (6.8%) in 2017; 211,599 (6.9%) in 2018; 210,842 (6.9%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 2%. We noted that the highest all cases of deaths rate before the pandemic was in the Krasnodar Territory and the Rostov region, decreasing yearly. In other regions, there went down. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 30) and 2021 (see Figure 31). We saw a predominantly high mortality rate in the northeastern part of the district. Chart all-cause deaths were considered by taking into account data from previous years in the Southern Federal District was taken into account taking into account data for previous years. The average monthly mortality in 2020 (see Figure 32) was at 123 (108-137) per 100,000 people, corresponding to 2009. The peak was at 29,315 (177 per 100,000) at the end of the year. The corresponding for 2019 was 104 per 100,000 people. The expected number of deaths based on previous years was considerably lower (193,035); thus, all cases of deaths were

26.2% higher than expected. In 2021 (see Figure 33), we noted average monthly mortality of 148(132-163) per 100,000 people, and the same high value falls on the penultimate month of 31,141 (189 per 100,000). We recorded the apex value of the corresponding indicator for the last 15 years in 2006 at 174 (164-184). All cases of deaths in 2021 were 49% higher than expected (158,117).

2020 and 2021 in the district, we saw the minimum number of average monthly mortality in the Republic of Kalmykia as 92 (80-104) and 112 (98-126) per 100,000 people. Therefore, the number of deaths in this region was minimal in the district 2020-3,000 and 2021-3,633. On the other hand, the Volgograd Region had a maximum average monthly mortality of 131 (115-147) in 2020 and 157 (13-176) in 2021. At the same time, the maximum number of deaths during the observed period in the district noted in the Krasnodar Territory, which was 80,802 and 97,138, with an average monthly mortality of 118 (102-134), 142 (127-156) in 2020 and 2021. The actual data and additional graphs for each region used for plotting charts and maps in the form of a summary table are attached (see Appendix).

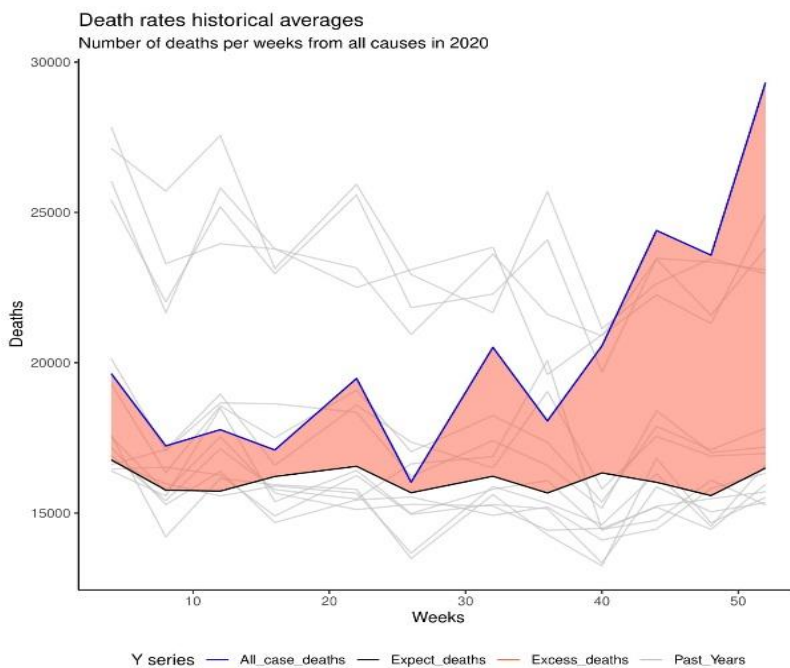


Figure 32 Number of deaths per weeks from all causes in SOUTHERN FD 2020

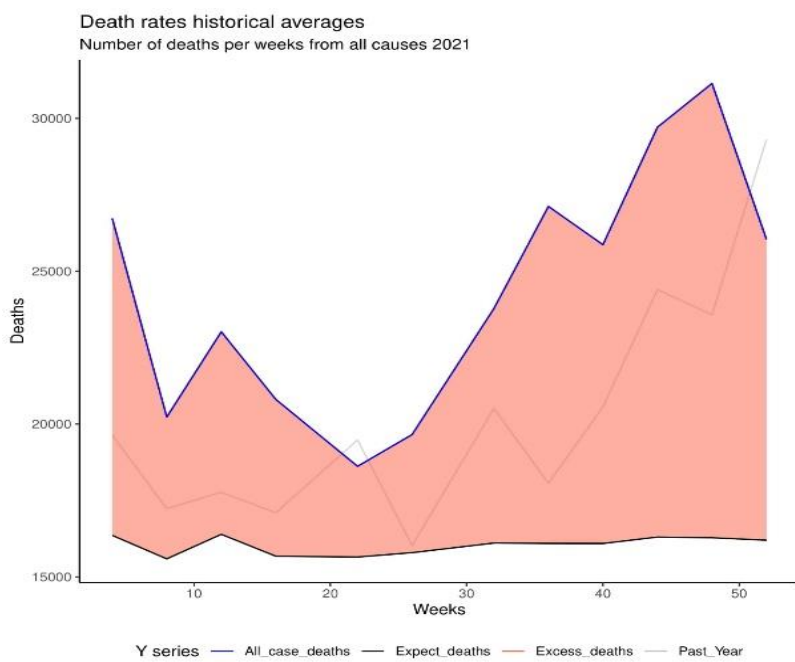


Figure 33 Number of deaths per weeks from all causes in SOUTHERN FD 2021

NORTH CAUCASUS FEDERAL DISTRICT (NCFD)

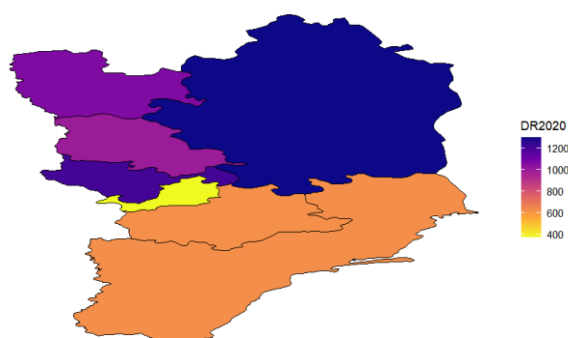


Figure 34 Mortality map in NCFD in 2020

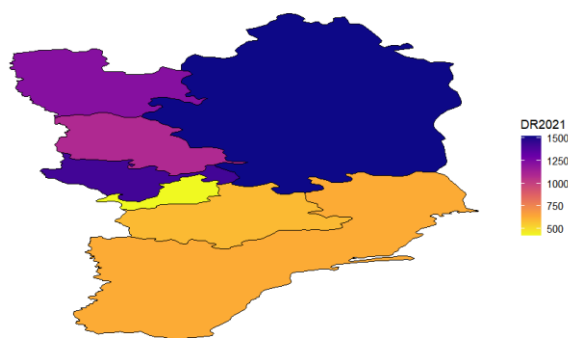


Figure 35 Mortality map in NCFD in 2021

From 2006 to 2019, 1,090,848 people died from all causes of the NCFD. Splitting in the year, we observe 83,763 (7.7%) in 2006; 79,512 (7.3%) in 2007; 79,844 (7.3%) in 2008; 82,138 (7.5%) in 2009; 80,810 (7.4%) in 2010; 80,194 (7.4%) in 2011; 78,397 (7.2%) in 2012; 76,719 (7%) in 2013; 77,665 (7.1%) in 2014; 76,680 (7%) in 2015; 75,649 (6.9%) in 2016; 74,136 (6.8%) in 2017; 72,910 (6.7%) in 2018; 72,431 (6.6%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 1%. Since 2009, all cases of deaths from all causes have been increasing in the Republic of Dagestan, decreasing the intensity of the pandemic. We noted that the highest all cases of deaths rate before the pandemic was in the Stavropol Territory, decreasing every next year. In other regions, there went down. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 34) and 2021 (see Figure 35). We saw a predominantly high mortality rate in the central northern part of the district. Chart all-cause deaths were considered by taking into account data from previous years in the North Caucasus Federal District was taken into account taking into account data for previous years. The average monthly mortality in 2020 (see Figure 36) was 74 (65-83) per 100,000 people, corresponding to the level out 2006. The peak was at 10,845 at the end of the year (109 per 100,000. The corresponding for 2019 was 62 per 100,000 people. The expected number of deaths based on previous years was higher (135,029); thus, the expected all cases of deaths were 34.4% higher than the observed one. In 2021 (see Figure 37), we detected the top average monthly mortality for the last 15 years, 81(72-91) per 100,000 people. Also, the highest value fell last month at 10,380 (165 per 100,000). The expected all cases of deaths in 2021 were 26% higher than the observed one (134,185).

In 2020 - 2021, in the Republic of Ingushetia, we saw the lowest number of average monthly deaths and deaths in the district. In total, in 2020, 1,891 people died in the Republic, with an average monthly mortality of 30 (25-35) per 100,000 people. The corresponding 2021 are 2,194 people and 35 (31-38) per 100,000 people. The region with the apex monthly mortality and number of deaths was the Stavropol Territory. In 2020, we saw 107(95-120) per 100,000 people, with all cases of deaths at 36,212. This was the only region in which the expected all cases of deaths based on previous years were higher than the observed one, which was 5.8% (34,213). Similarly, in 2021, we recorded average monthly mortality of 126 (110-142) and 42,282 deaths, which was 23.7% higher than expected. The actual data and additional graphs for each region used for plotting charts and maps in the form of a summary table are attached (see Appendix).

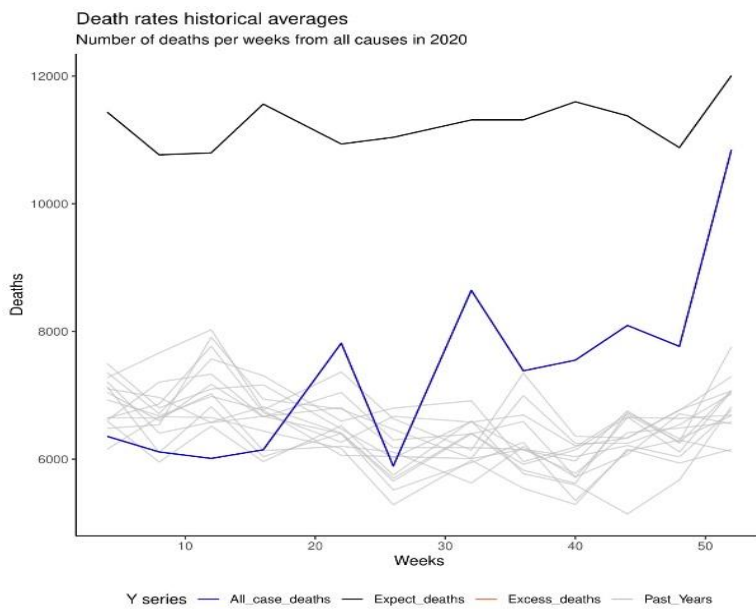


Figure 36 Number of deaths per weeks from all causes in NCFD in 2020

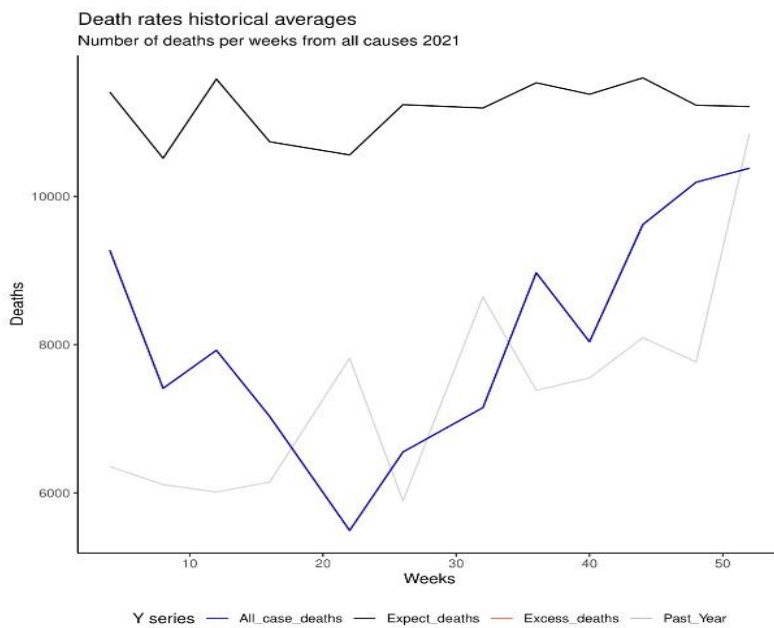


Figure 37 Number of deaths per weeks from all causes in NCFD in 2021

VOLGA FEDERAL DISTRICT (VFD)

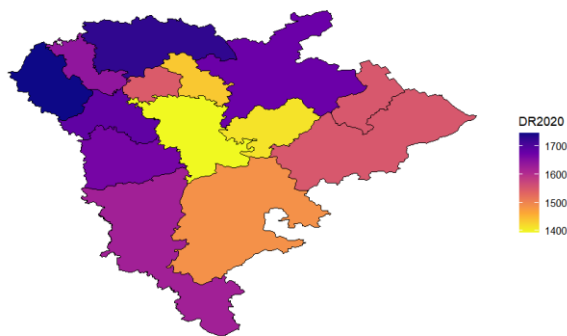


Figure 38 Mortality map in VFD in 2020

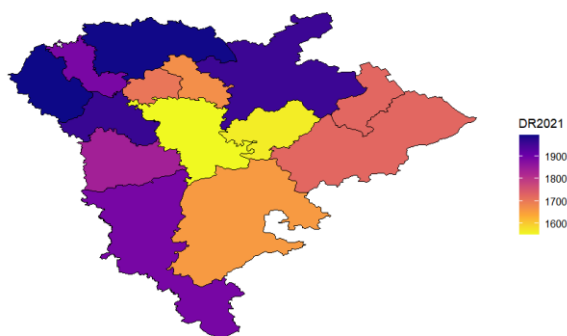


Figure 39 Mortality map in VFD in 2021

From 2006 to 2019, 1,090,848 people died from all causes of the VFD. Splitting in the year, we observe 473,222 (8%) in 2006; 458,637 (7.7%) in 2007; 458,040 (7.7%) in 2008; 441,171 (7.4%) in 2009; 450,333 (7.6%) in 2010; 426,682 (7.2%) in 2011; 414,518 (7%) in 2012; 415,902 (7%) in 2013; 414,389 (7%) in 2014; 413,435 (7%) in 2015; 402,835 (6.8%) in 2016; 388,332 (6.6%) in 2017; 390,701 (6.6%) in 2018; 379,872 (6.4%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 1.7%. We noted that the highest all cases of deaths rate before the pandemic was in the Nizhny Novgorod region, which decreases yearly. In other regions, its decline was also observed. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 38) and 2021 (see Figure 39). We saw a predominantly high mortality rate in the northwestern part of the district. Chart all-cause deaths were considered by taking into account data from previous years in the Volga Federal District was taken into account taking into account data for previous years. The average monthly mortality in 2020 (see Figure 40) was 131(115-146) per 100,000 people. The peak was at 50,352 (172 per 100,000) at the end of the year, the top value for the 2 studied years. The corresponding for 2019 was 106 per 100,000 people. Based on previous years, the expected number of deaths was considerably lower (338,308); thus, all cases of deaths were

36% higher than expected. In 2021 (see Figure 41), we marked the highest average monthly mortality for the last 15 years, 149 (130-152) per 100,000 people. Also, the apex value falls in the first month of 62,298 (215 per 100,000). This was the leading indicator for two years of the pandemic in all districts. Therefore, in 2021 had observed all cases of deaths were 56% higher than expected (333,519).

In 2020, the district saw the lowest average monthly mortality in Tatarstan, 116 (101-130) and the Republic of Mari El 119(105-133). At the same time, one of the top total deaths was recorded in Tatarstan in 2020 (54,276), while in Mari El, only 9,720, the smallest number of deaths in the district. The corresponding indicator was also the minimum in 2021 – 11,249, and the average monthly mortality was 139 (125-153). However, the minimum mortality in 2021 was recorded in Tatarstan 129(109-148), with a total number of deaths at 603,301, which was also one of the highest deaths in the district. The maximum region was Bashkortostan 66,366, with monthly mortality of 138 (117-158). The actual data and additional graphs for each part used for plotting charts and maps in a summary table are attached (see Appendix).

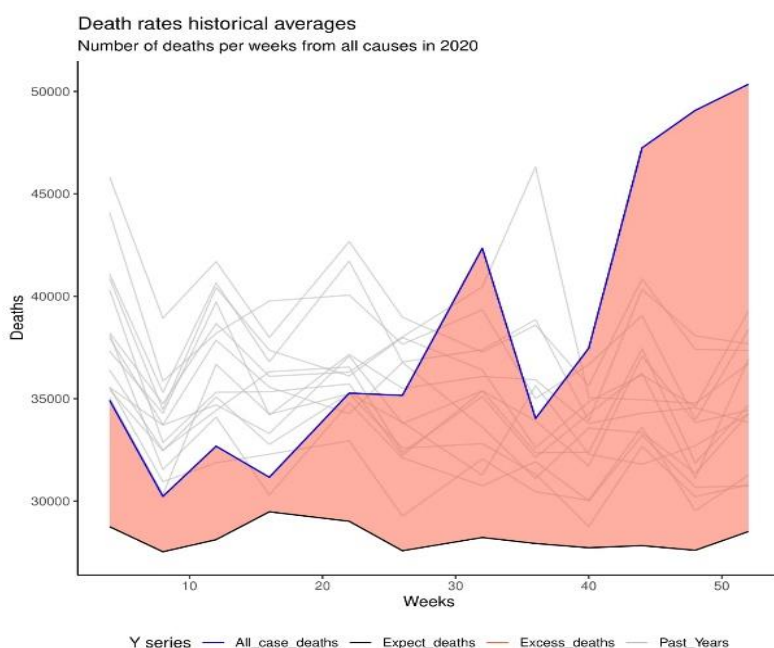


Figure 40 Number of deaths per weeks from all causes in VFD in 2020

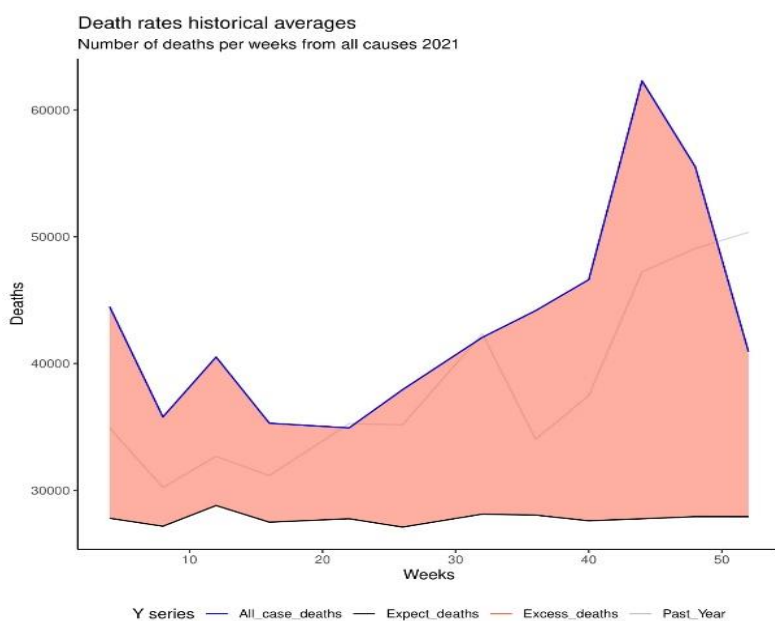


Figure 41 Number of deaths per weeks from all causes in VFD in 2021

URAL FEDERAL DISTRICT (UFA)

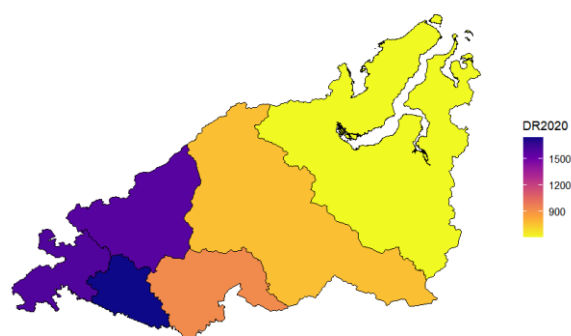


Figure 42 Mortality map in UFA in 2020

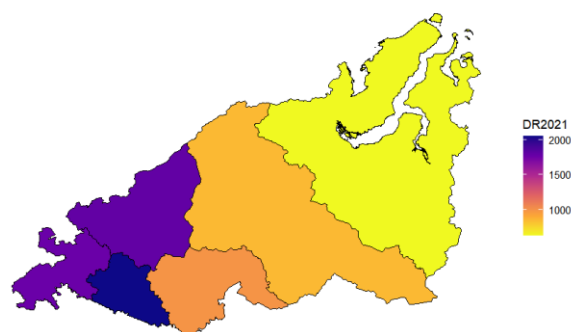


Figure 43 Mortality map in UFA in 2021

From 2006 to 2019, 2,161,364 people died from all causes in the Ural Federal District. Splitting in the year, we observe 168,166 (7.8%) in 2006; 162,317 (7.5%) in 2007; 164,247 (7.6%) in 2008;

158,185 (7.3%) in 2009; 156,790 (7.3%) in 2010; 153,685 (7.1%) in 2011; 152,793 (7.1%) in 2012; 151,361 (7%) in 2013; 152,037 (7%) in 2014; 153,802 (7.1%) in 2015; 151,492 (7%) in 2016; 144,961 (6.7%) in 2017; 146,840 (6.8%) in 2018; 144,688 (6.7%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 1%. We noted that the highest all cases of deaths rate before the pandemic was in the Sverdlovsk region, decreasing every year. In other regions, there was an annual decline. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 42) and 2021 (see Figure 43). We saw a predominantly high mortality rate in the southwestern part of the district. Chart all-cause deaths were considered by taking into account data from previous years in the Ural Federal District was taken into account taking into account data for previous years. The average monthly mortality in 2020 (see Figure 44) was 115 (100-130) per 100,000 people, corresponding to 2006. The peak was detected in the penultimate month at 19,169 (155 per 100,000). The corresponding for 2019 was 90 per 100,000 people. Based on previous years, the expected number of deaths was considerably lower (147,585); thus, all cases of deaths were 16.1% higher than expected. In 2021 (see Figure 45), we marked the highest average monthly mortality for the last 15 years of 130 (114-147) per 100,000 people. Also, the apex value falls in the penultimate month of 22,342 (181 per 100,000). Therefore, in 2021 had observed all cases of deaths were 31% higher than expected (146,934).

In 2020-2021, we saw the lowest number of average monthly deaths in the Yamalo-Nenets region., 50(43-57) and 52(46-59) per 100,000 people. Also, in the area, the minimum value of the number of deaths for two years was 3,284 in 2020 and 3,474 in 2021. On the other hand, the expected number of deaths was higher than observed in both years (8,117(60%) and 8,119(57%)). The maximum value of the average monthly mortality in 2020-2021 was observed in the Kurgan region 144 (125-163) and 170 (148-192). At the same time, the value of the number of deaths was one of the smallest in the district, 14,271 in 2020 and 16,633 in 2021. The maximum number of deaths in the district for two years was recorded in the Sverdlovsk region, which amounted to 67,381 and 76,873, with an average monthly mortality of 130 (113-147) and 149 (131-168). The actual data and additional graphs for each region used for plotting charts and maps in the form of a summary table are attached (see Appendix).

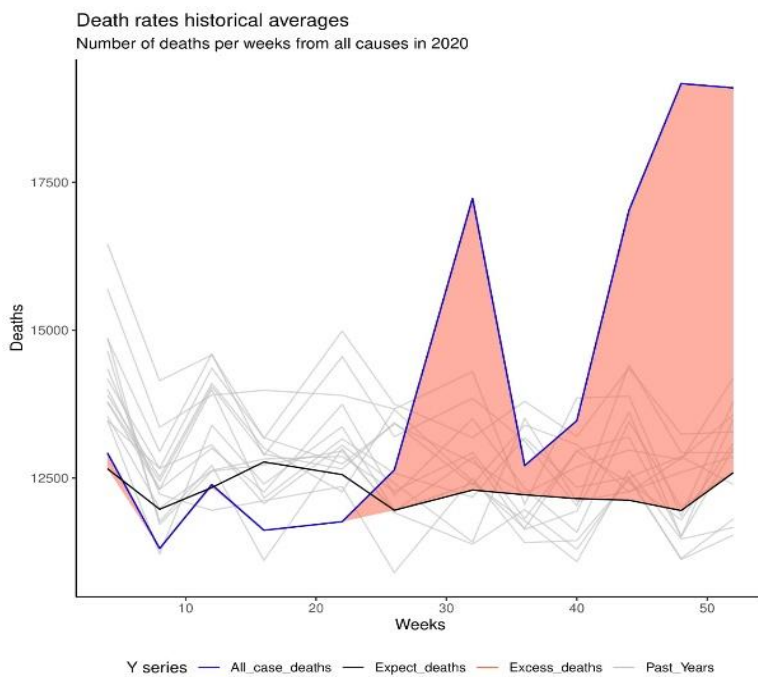


Figure 44 Number of deaths per weeks from all causes in UFA in 2020

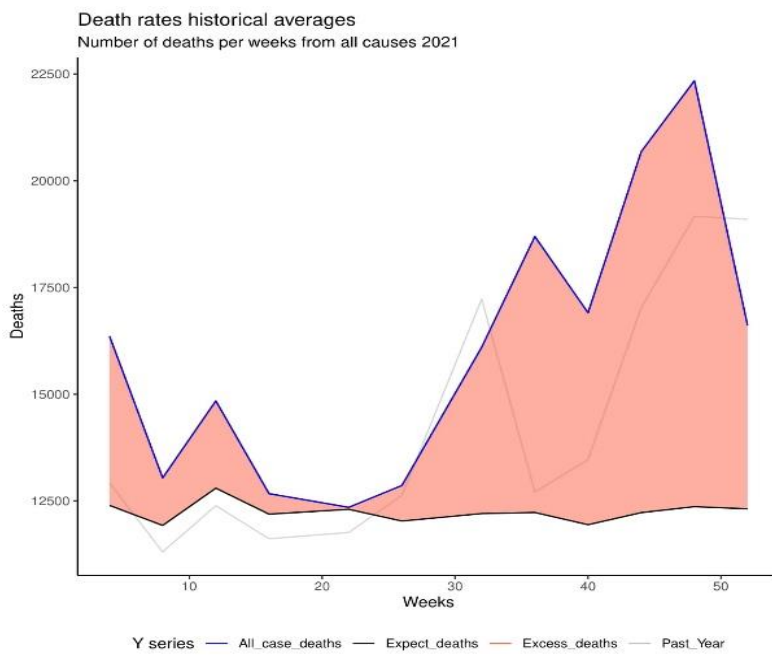


Figure 45 Number of deaths per weeks from all causes in UFA in 2021

SIBERIAN FEDERAL DISTRICT (SIBERIAN FD)

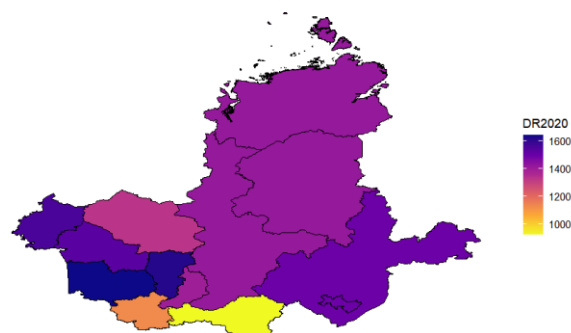


Figure 46 Mortality map in SIBERIAN FD in 2020

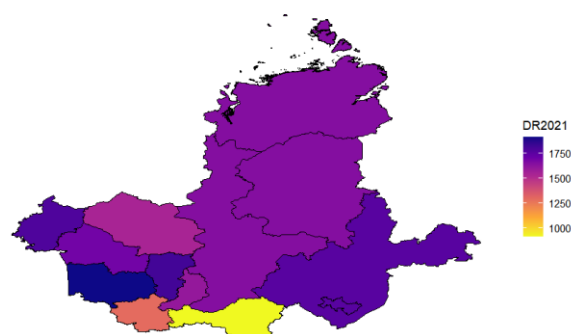


Figure 47 Mortality map in SIBERIAN FD in 2021

From 2006 to 2019, 3,663,633 people died from all causes in the Siberian Federal District. Splitting in the year, we observe 296,586 (8,1%) in 2006; 282,078 (7,7%) in 2007; 281,599 (7,7%) in 2008; 272,543 (7,4%) in 2009; 273,424 (7,5%) in 2010; 264,754 (7,2%) in 2011; 262,286 (7,2%) in 2012; 257,282 (7%) in 2013; 256,083 (7%) in 2014; 255,424 (7%) in 2015; 251,212 (6,9%) in 2016; 245,256 (6,7%) in 2017; 243,577 (6,6%) in 2018; 221,529 (6%) in 2019. The data indicate an annual decrease in all cases of deaths in the district by 2%. We noted that the highest all cases of deaths rate before the pandemic was in the Kemerovo region, decreasing every following year. In other regions, there went down. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 46) and 2021 (see Figure 47). Chart all-cause deaths were considered by taking into account data from previous years in the Siberian Federal District was taken into account taking into account data for previous years. We saw a predominantly high mortality rate in the central part of the district. The average monthly mortality in 2020 (see Figure 48) was 125(109-141) per 100,000 people, corresponding to 2008. The peak was observed at the end of the year at 30,122 (176 per 100,000). The corresponding for 2019 was 99 per 100,000 people. The expected number of deaths based on previous years was considerably lower (199,655); thus, the observed number of deaths was

28.4% higher than expected. In 2021 (see Figure 49), we detected the apex average monthly mortality for the last 15 years, 143(130-152) per 100,000 people. Also, the highest value falls in the penultimate month of 30,425 (179 per 100,000). The observed all cases of deaths in 2021 were 48% higher than expected (197,075).

In 2020-2021, we saw in the district the minimum number of average monthly mortality in the Republic. Tyva 76(69-83) and 76(67-84) per 100,000 people. The region also recorded the smallest number of deaths in the district in two years, 3,024 in 2020, which was 55% less than expected (6,711) and 3,028 in 2021, which was also 55% lower than expected (6,670). Altai Krai was the region with the maximum average monthly mortality in the district of 136 (113-160) in 2020 and 159 (141-177) in 2021. One maximum number of deaths in 2 years was observed in the Kemerovo region, 42,795 in 2020 with an average monthly death of 134 (117-152) and 47,604 in 2021 with an average monthly death of 151 (135-167). The actual data and additional graphs for each region used for plotting graphs and maps in a summary table are attached (see Appendix).

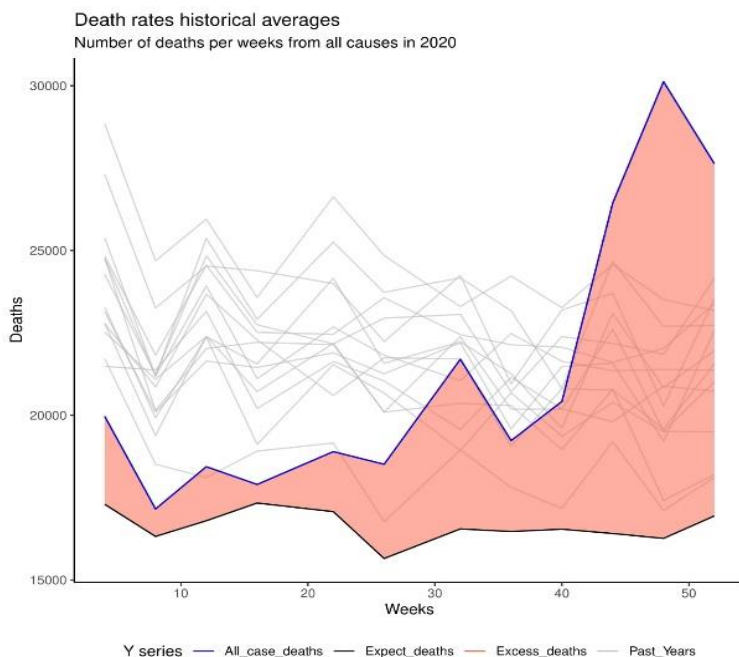


Figure 48 Number of deaths per weeks from all causes in SIBERIAN FD in 2020

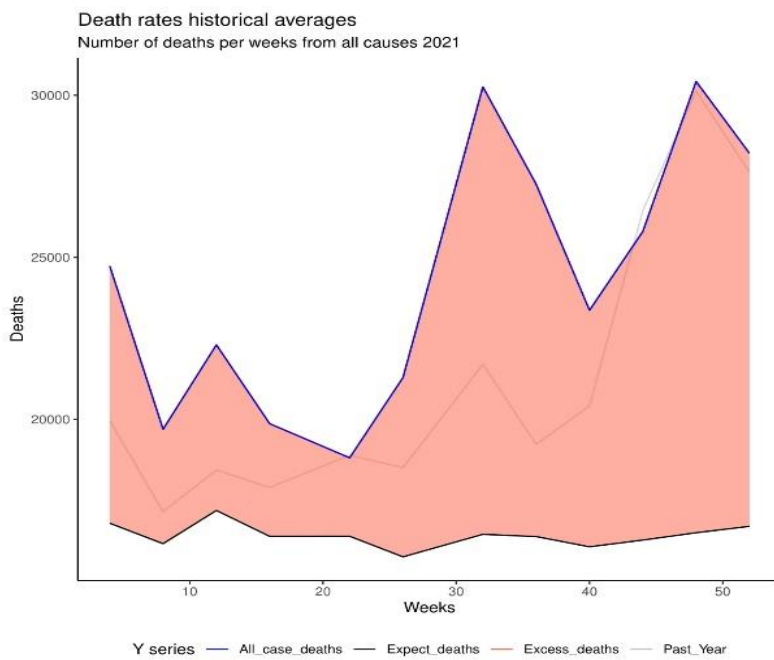


Figure 49 Number of deaths per weeks from all causes in SIBERIAN FD in 2021

FAR EASTERN FEDERAL DISTRICT (FEFD)

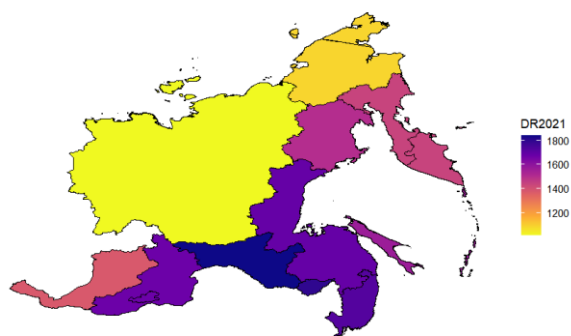


Figure 50 Mortality map in FEFD in 2020

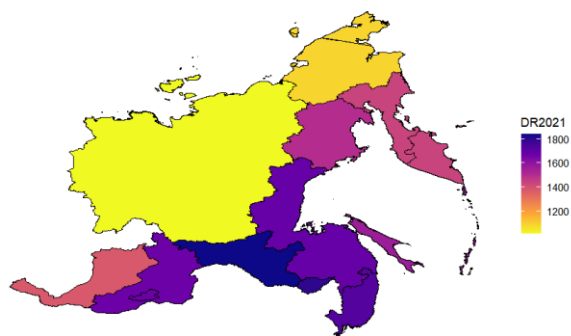


Figure 51 Mortality map in FEFD in 2021

From 2006 to 2019, 1,172,586 people died from all causes in the Far Eastern Federal District. Splitting in the year, we observe 91,680 (7.8%) in 2006; 87,571 (7.5%) in 2007; 88,637 (7.6%) in 2008; 85,627 (7.3%) in 2009; 86,845 (7.4%) in 2010; 84,352 (7.2%) in 2011; 81,494 (6.9%) in 2012; 78,890 (6.7%) in 2013; 78,301 (6.7%) in 2014; 78,442 (6.7%) in 2015; 77,398 (6.6%) in 2016; 74,715 (6.4%) in 2017; 78,632 (6.7%) in 2018; 100,002 (8.5%) in 2019. The data indicate no annual decrease in all cases of deaths in the district. We noted that the highest all-cases of deaths rate before the pandemic was in the Primorsky Territory, decreasing every next year. In other regions, there went down. The map shows the level of mortality from all causes in the country per 100,000 people in 2020 (see Figure 50) and 2021 (see Figure 51). Chart all-cause deaths were considered by taking into account data from previous years in the Far Eastern Federal District was taken into account taking into account data for previous years. We saw a predominantly high mortality rate in the southeastern part of the district. The average monthly mortality in 2020 (see Figure 52) was 114.59 (99-130) per 100,000 people, corresponding to 2007 and 2010. The peak was observed at the end of the year at 14,360 (176 per 100,000), the top value for the 2 studied years. The corresponding for 2019 was 100 per 100,000 people. Based on previous years, the expected number of deaths was considerably lower (96,219); thus, the observed all-cases of deaths were 16.5% higher than expected. In 2021 (see Figure 53), we marked the apex average monthly mortality for the last 15 years of 129.74 (117-141) per 100,000 people. Also, the highest value falls in the first month of 12,505 (154 per 100,000). Therefore, in 2021 observed all-cases of deaths were 33% higher than expected (94,489).

In 2020-2021, we saw in the district that the minimum number of average monthly deaths in the Sakha Republic was 76 (65-87) and 84 (73-94) per 100,000 people, with 8,956 and 10,600 deaths. However, the corresponding minimum indicator for two years was recorded in the Chukchi region of 522 and 540, with an average monthly mortality of 87 (76-98) and 90 (76-103). The maximum average monthly mortality for two years in the district was observed in the Amur region 134 (113-155), and the number of deaths was 12,677 in 2020 and 153 (136-170) and 14,298 in 2021. At the same time, we observe the maximum number of deaths in the Primorsky Territory, which was 28,837 with monthly mortality of 127 (106-148) in 2020 and 31,904 with the corresponding indicators of 142 (128-155) in 2021. Therefore, the observed all-cases of deaths in this region exceed the expected by 27% (22,751) in 2020 and 42% (22,409) in 2021. The actual data and additional graphs for each part used for plotting charts and maps in a summary table are attached (see Appendix).

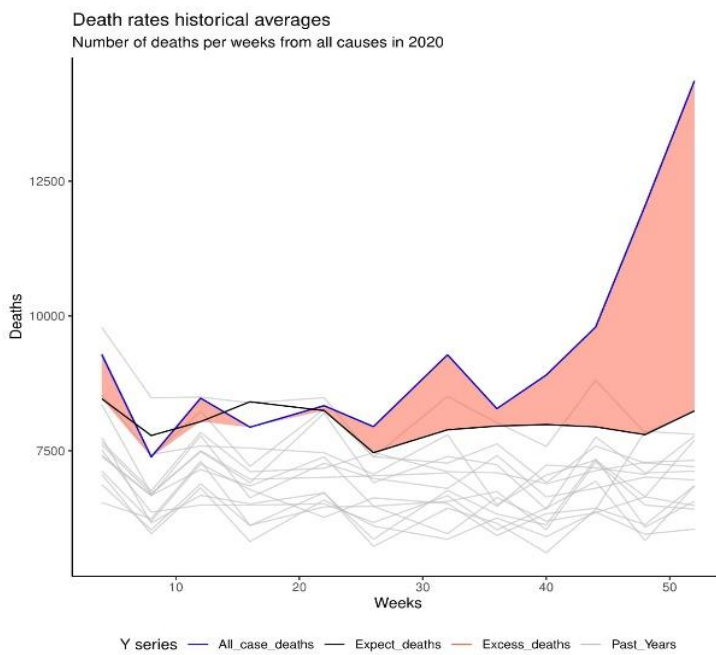


Figure 52 Number of deaths per weeks from all causes in FEFD in 2020

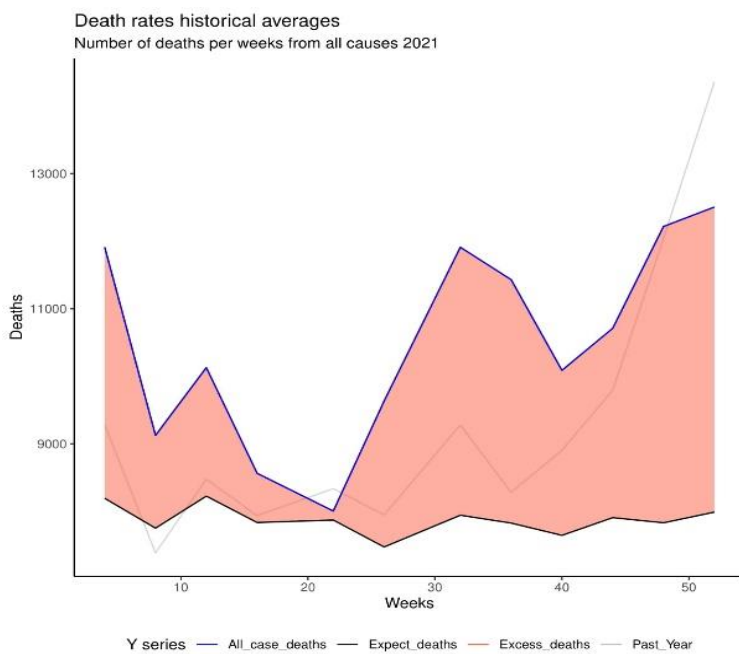


Figure 53 Number of deaths per weeks from all causes in FEFD in 2021

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Russia	126,16	121,38	121,49	117,52	118,48	112,21	110,5	109,07	107,2	108,8	107,26	103,53	103,74	102,24	120,88	139,71
Central Federal District	135,51	130,72	130,51	125,25	126,89	116,06	115,73	114,05	113,62	112,47	111,98	107,47	107,55	105,3	125,07	145,84
Far Eastern Federal District	118,83	114,32	116,25	112,74	114,83	112,01	108,51	105,37	104,92	105,38	104,22	100,85	79,86	101,89	114,59	129,74
North-Western Federal District	137,47	129,03	129,51	125,34	124,29	115,8	114,33	111,73	110,82	111,39	109,91	106,45	104,93	103,39	120,58	141,8
North Caucasus Federal District	77,01	72,5	72,11	73,52	71,67	70,6	68,65	66,84	67,25	65,96	64,68	63,04	61,72	60,98	74,23	81,85
Siberian Federal District	127,22	121,6	121,64	117,77	118,25	114,58	113,43	111,17	110,56	110,18	108,33	105,86	118	107,67	125,23	143,58
Southern Federal District	174,72	168,18	167,39	165,93	117,39	113,98	111,16	109,61	111,32	110,9	94,19	105,47	107,21	106,74	123,26	148,2
Ural Federal District	115,77	112	113,35	109,11	108,1	105,71	104,62	103,26	103,38	104,27	102,41	97,81	99,06	97,59	115,66	130,94
Volga Federal District	129,9	126,53	126,81	122,45	125,36	119,14	115,95	116,48	116,16	116,03	113,2	109,37	110,48	107,89	131,36	149,8

3Average monthly mortality from all causes per 100,000 people from 2006 to 2021 (color gradient)

Name	Year	Monthly Mean mortality rate per 100.000 people	Confidence interval	Mortality rate per 100.000 people	All case deaths Max	All case deaths Min	All case deaths	Expect deaths	Excess deaths	%
Volga Federal District	2020	131,36	115,9-146,82	1576,28	50352	30230	459950	338308,6	121641,4	36%
Siberian Federal District	2020	125,23	109,28-141,19	1502,81	30122	17153	256396	199655	56740,99	28%
Central Federal District	2020	125,07	111,88-138,26	1500,81	67568	39805	590455	449131	141324	32%
Southern Federal District	2020	123,26	108,58-137,93	1479,07	29315	16026	243668	193035,7	50632,35	26%
Russia	2020	120,88	107,61-134,15	1450,55	243235	143179	2124479	1702400	422079,2	25%
North-Western Federal District	2020	120,58	108,26-132,9	1446,95	24066	13953	202022	159758,4	42263,57	27%
Ural Federal District	2020	115,66	100,38-130,93	1387,88	19169	11307	171335	147585,9	23749,14	16%
Far Eastern Federal District	2020	114,59	99,08-130,11	1375,12	14360	7385	112026	96219,02	15806,98	16%
North Caucasus Federal District	2020	74,23	65,05-83,42	890,8	10845	5892	88627	135029,5	-46402,5	-34%

4Summary table of descriptive statistics in RF in 2020

Name	Year	Monthly Mean mortality rate per 100.000 people	Confidence interval	Mortality rate per 100.000 people	All case deaths Max	All case deaths Min	All case deaths	Expect deaths	Excess deaths	%
Volga Federal District	2021	149,8	131,59-168,01	1797,61	62298	34928	520539	333519,7	187019,3	56%

Southern Federal District	2021	148,2	132,59-163,81	1778,35	31141	18616	292693	192540,1	100153	52%
Central Federal District	2021	145,84	132,82-158,85	1750,02	72859	47765	685617	449723,5	235893,5	53%
Siberian Federal District	2021	143,58	128,23-158,93	1722,96	30425	18813	291987	197075,3	94911,71	48%
North-Western Federal District	2021	141,8	130,92-152,69	1701,66	23030	15738	236897	158117,2	78779,84	50%
Russia	2021	139,71	126,76-152,67	1676,57	257292	162283	2445509	1690102	755407,4	45%
Ural Federal District	2021	130,94	114,27-147,62	1571,33	22342	12351	193469	146934,7	46534,3	32%
Far Eastern Federal District	2021	129,74	117,97-141,5	1556,84	12505	8004	126222	94489,96	31732,04	34%
North Caucasus Federal District	2021	81,85	72,12-91,57	982,16	10380	5494	98043	134185,6	-36142,6	-27%

5Summary table of descriptive statistics in Russia in 2021

Discussion

Summary

In our study, we describe mortality from all causes during the COVID-19 pandemic in Russia. Over the past 15 years, mortality in the country has consistently decreased by 1% annually. The leading cause of death of Russians is various diseases. The jump in deaths detected in the last two years can be attributed to the impact of the pandemic on the population. Surveillance and Rosstat data on total mortality are essential public health tools both for monitoring and for the correct response to the consequences of the pandemic, taking into account the chronology of events. More than 4.5 million people died from all causes in just two years. From the pandemic's beginning until December 31, 2021, 10.5 million disease cases have been confirmed, and 240.4 million tests have been conducted. The total number of patients under observation was 34.5 million people, while 1.2 were under the supervision of doctors at the end of the year. The chronology shows how the pandemic has challenged the healthcare system, economy, and industry. A sharp rise in the construction of new (temporary) hospitals and the involvement of all possible medical personnel to overcome the consequences of the pandemic has been observed. The state authorities urgently established the production of personal protective equipment, medical equipment (ventilators) and its delivery to the regions, staff training, deployment of information systems for alerting and monitoring citizens, restrictions on operating entertainment centres, testing and production of vaccines. The Armed Forces of the Russian Federation were involved in the problem of the pandemic to help healthcare. [41] The government's

measures also included financial incentives for medical staff and maintenance personnel. Additionally, 423 billion rubles (7 billion dollars) were allocated to provide the regions with COVID-19. During the pandemic, various preventive solutions were introduced to prevent the spread of the virus: self-isolation, lockdowns, remote work, wearing masks and gloves, restriction of movement in public transport for students and pensioners, and cancellation of celebrations of national and religious holidays. [9]

Four waves of the pandemic have ended in Russia. Each of them led to increased mortality in most regions and districts. Restrictions imposed by the government partially restrained the spread of the virus, while the bed fund was actively increasing. For the federal districts, the leading factor in the increase in mortality was geographical location and population density. [18] The regions located in the central part of the country have been most affected by the spread of COVID-19. This is likely due to the abundance of transport hubs and airports, as well as proximity to the borders of the European Union.[28] Cities in federal districts with a population of more than a million (15 out of 1099) are socio-economic centres with highly developed infrastructure and population migration (labour and educational).[46] Consequently, we see the most significant deaths from all causes in the Central Federal District, Northwestern Federal District, Southern Federal District, Volga Federal District and Siberian Federal District.

The Central District is the largest district in terms of population, density and number of subjects. In the Central Federal District, the capital, Moscow and the Moscow Region are noted as the most densely populated regions with one of the lowest mortality rates. It is necessary to pay attention to all the active measures of the government of the city of Moscow, which later became a model for recommendations for other regions recorded in chronology. In the Northwestern Federal District, similar positive active actions were taken in the northern capital city of St. Petersburg, which is also the most densely populated region in this district. Four of the six regions bordering the Central Federal District recorded the highest mortality rates in the Southern Federal District and are also the leading densely populated regions. In chronology, we noted that government measures were actively taken only at the end of 2021. In the Volga Federal District, seven of the fourteen regions observe a high mortality rate in the northwestern part of the district. Only two regions (Samara Region and Nizhny Novgorod region) are densely populated. The government's measures are fixed only in the fall of 2021. In the Siberian Federal District, the only region in the entire district with a low mortality rate is the Republic of Tyva. The region borders Mongolia and is one of the most sparsely populated in the district. Only one region (Krasnoyarsk Territory) is densely populated.

However, the Far Eastern Federal District, the North Caucasus Federal District and the Ural Federal District had the lowest deaths from all causes in 2 years. The North Caucasus Federal District is the smallest in terms of territory. In the NCFD, active support measures were carried out in all regions during the pandemic in 2020 and 2021, which are indicated in the chronology. The region with a high mortality rate is the Stavropol Territory. It is also one of the most densely populated regions bordering neighbouring districts. Until 2010, the district was part of the Southern Federal District. Due to its geographical features, Ural Federal District is physically separated from the European part of Russia by the Ural Mountains. Despite this, one of the first cases of the virus was recorded in the Tyumen region. In four of the five regions, government support measures were carried out, as noted in the chronology. Sverdlovsk region, the most densely populated region with a high mortality rate, is the centre of the UFD. The Far Eastern Federal District is the smallest in population size and density. Also, one of the first cases of coronavirus infection was recorded in the Trans-Baikal Territory. The regions bordering the People's Republic of China (PRC) have the highest mortality. The low mortality rate during a pandemic may be associated with a different combination of cultures. (considering that more than 160 nationalities live in the country). We also need to pay attention to the peculiarities of the area where the population lives (mountainous terrain – North Caucasus Federal District, taiga and tundra terrain of the Far Eastern Federal District and Ural Federal District).[13]

Comparison with other studies

Our conclusions are similar to the results of "Tracking excess mortality across countries during the COVID-19 pandemic with the World Mortality Dataset" and "Excess mortality during the Coronavirus pandemic (COVID-19)"[21]. In these studies, the authors presented the World Mortality Dataset, the largest international dataset on mortality from all causes, currently covering 103 countries. [14] The data set is publicly available and is regularly updated. The researchers concluded that there are differences between the data on mortality in Russia from coronavirus. [21] At the same time, they also showed potentially excessive mortality, which is associated with the impact of the pandemic. The authors also suggest that several countries (Russia is included in this list) underestimated data on deaths during the COVID-19 pandemic. Unfortunately, there are no more detailed studies with a detailed description of Eastern Europe and the Eurasian continent.

Strengths and limitations of this study

The data in the dataset used in our study was obtained from a publicly available official source. It has to be acknowledged that the data for 2020-2021 are often preliminary or not fully specified. Rosstat recognizes that data verification is carried out manually. [10] Reviewing data for previous years (controversial positions) is a practice. The data source is a single official state source with the availability of all necessary passports for documents. These data are the only official ones, and there are no sources that could be used for verification or comparison. The author focuses on the pandemic period and describes mortality from all causes, not from COVID-19. However, COVID-19-specific mortality is very challenging to obtain not only in Russia and strongly depends on its definition. The estimations did not consider geographical features, the influence of natural disasters or other external factors, which would have made the estimations too complex. Moreover, the dataset does not include Crimea for the Southern Federal District because of its disputed status. The data on the incidence rate is based on serological and PCR tests from officially published daily reports, and there are also no alternative sources for monitoring. Thus, infected people may have been missed in the analyses. There is also a delay in postmortem biological samples. Therefore, it is complicated to determine the differences between deaths from COVID-19 and deaths recorded in non-core medical institutions. In addition, we do not know the exact cause of death in people who tested positive for SARS-CoV-2.

Conclusion

The pandemic of a multisystem disease affected different territories of the country, completing the fourth wave of the pandemic. The maximum number of registered deaths from all causes was recorded in large settlements and adjacent territories. The spatial analysis expanded the understanding of the process of spreading infectious diseases in the Russian Federation. From our point of view, the results of health care activities, the significant deterioration of public health and the complication of the demographic situation in the country during the pandemic indicate severe shortcomings in the organization of medical care to the population, especially in extreme situations, and require in-depth analysis and adequate measures to improve the structure and functioning of the health system and industry in any conditions. The level of development of the healthcare system, demographic and migration factors have a significant impact at different stages of the pandemic. Our results highlight the importance of correctly and timely accounting of deaths from all causes to consider indirect effects and potential consequences and make them publicly available.

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APPENDIX

All the necessary information is contained in the GitHub repository. You can use a QR code or a link to ease of use.

<https://github.com/SergeevDmi/Pandemia-in-Russia-2020-2021/blob/main/APPENDIX.edited.pdf>

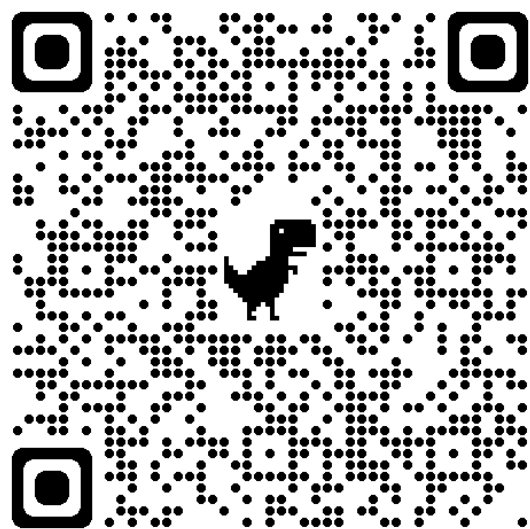


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