ANALYSIS OF THE RELATIONSHIP BETWEEN MORBIDITY, MORTALITY AND RESTRICTIVE MEASURES IN DIFFERENT COUNTRIES DURING THE COVID-19 PANDEMIC

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Abstract

Introduction: The pandemic of the new coronavirus infection COVID-19 has posed the need for the healthcare system to promptly address the issues of organizing medical care for an increasing flow of patients. The scale of the pandemic has shown that no State has sufficiently demonstrated a high willingness to respond quickly and implement measures to reduce the outbreak of infection.

The purpose of the study: To study morbidity and mortality in terms of the number of restrictive measures taken in different countries during the COVID-19 pandemic.

Materials and methods: For the analysis, open sources of information from the Our World in Data portal were used, where world statistics on the COVID-19 pandemic were collected and systematized. The data analysis period is March 2020 to the present. The analysis includes countries such as the USA, Great Britain, Italy, Canada, India, China, Turkey, Israel, Russia and Kazakhstan. For the analysis, databases on the number of confirmed cases of the disease, the number of confirmed deaths and the severity index of restrictive measures were studied. A Spearman correlation analysis of the dependence of cases of diseases, deaths and Severity Index was carried out.

Results and discussion: On March 11, 2020, the World Health Organization (WHO) announced the COVID-19 pandemic in the world. The incidence of coronavirus began to rise sharply, especially in European countries, despite the fact that there was not enough information about the virus, which caused panic among the world's population. In addition to the increase in morbidity, the level of mortality increased. Since 2020, restrictive measures have been introduced in many countries. It was difficult to assess the effectiveness of the implemented measures immediately. 2 years later, a Severity Index was developed, which took into account all the restrictive measures applied in the countries.

The correlation analysis showed that the analysis of cases of disease and deaths for 04/18/2020 has a strong correlation r=0.732 (differences are statistically significant p=0.002), while the correlation of the Severity Index and deaths has a weak and statistically insignificant relationship (r=-0.067, p=0.814). The correlation analysis of the Severity Index and cases of the disease also have no correlation (r=0.036, p=0.899).

Conclusions: An analysis of the relationship between morbidity, mortality and restrictive measures during the COVID-19 pandemic showed that there was no correlation between the restrictive measures taken during the pandemic and the level of diseases and mortality in the studied countries. There is a direct and strong correlation between the level of diseases and deaths in 2020 and 2022.

Keywords: COVID-19 morbidity, COVID-19 mortality, restrictive measures, correlation analysis.

Резюме

АНАЛИЗ СВЯЗИ ЗАБОЛЕВАЕМОСТИ, СМЕРТНОСТИ И ОГРАНИЧИТЕЛЬНЫХ МЕР В РАЗНЫХ СТРАНАХ В ПЕРИОД ПАНДЕМИИ COVID-19

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Введение: Пандемия новой коронавирусной инфекции COVID-19, поставила перед системой здравоохранения необходимость оперативного решения вопросов организации медицинской помощи возрастающему потоку пациентов. Масштабы пандемии показали, что ни одно государство в достаточной степени не показали высокую готовность к быстрому реагированию и внедрению мероприятий по уменьшению вспышки инфекции.

Цель исследования: Изучить заболеваемость и смертность в разрезе количества принятых ограничительных мер в разных странах в период пандемии COVID-19.

Материалы и методы. Для анализа использованы открытые источники информации портала Our World in Data, где собраны и систематизированы данные мировой статистики по пандемии COVID-19. Период анализа данных март 2020 год по настоящее время. В анализ включены такие страны как США, Великобритания, Италия, Канада,

Индия, Китай, Турция, Израиль, Россия и Казахстан. Были изучены базы по количеству подтвержденных случаев заболевания, количеству подтверждённых случаев смерти и индекс строгости ограничительных мероприятий. Проведен корреляционный анализ по Спирмену зависимости случаев заболеваний, смертей и Индекса строгости.

Результаты и обсуждение. Всемирная организация здравоохранения (ВОЗ) 11 марта 2020 года объявила о пандемии COVID-19 в мире. Заболеваемость короновирусом резко начала повышаться, особенно в Европейских странах, при том, что информации о вирусе было не достаточно, что вызывало панические настроения среди населения всего мира. Помимо повышения заболеваемости увеличивался уровень сметрности. С 2020 года во многих странах внедрены ограничительные меры. Эффективностность внедряемых мер оценить сразу было затруднительно. Спустя 2 года был разработан Индекс строгости, в котором учли все примененные ограничительные мероприятия в странах.

Корреляционный анализ показал, что анализ случаев заболевания и смерти за 18.04.2020 г. имеет сильную корреляционную связь r=0,732 (различия статистически значимы р=0,002), в то время как корреляционная связь Индекса строгости и случаев смерти имеет слабую и статистически не значимую связь (r=-0,067, p=0,814). Корреляционный анализ Индекса строгости и случаев заболевания также не имеют корреляционной связи (r=0,036, p=0,899).

Выводы: Анализ связи заболеваемости, смертности и ограничительных мер в период пандемии COVID-19 показал отсутствие корреляционной связи между принятыми ограничительными мероприятиями во время пандемии и уровнем заболеваний и смертности в изучаемых странах. Имеется прямая и сильная корреляционная связь между уровнем заболеваний и смертей за 2020 и 2022 годы.

Ключевые слова: заболеваемость COVID-19, смертность COVID-19, ограничительные меры, корреляционный анализ.

Түйіндеме

ӨЛІМ МЕН ӨЛІМДІЛІКТІҢ БАЙЛАНЫСЫН ТАЛДАУ ЖӘНЕ ТҮРЛІ ЕЛДЕРДЕГІ COVID -19 ПАНДЕМИЯСЫ КЕЗІНДЕ ШЕКТЕУ ШАРАЛАРЫН САЛЫСТЫРУ

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Кіріспе: Covid-19 жаңа коронавирустық инфекциясының пандемиясы Денсаулық сақтау жүйесіне пациенттердің өсіп келе жатқан ағымына медициналық көмекті ұйымдастыру мәселелерін жедел шешу қажеттілігін туғызды. Пандемияның ауқымы бірде-бір мемлекет тез әрекет етуге және инфекцияның өршуін азайту жөніндегі іс-шараларды енгізуге жеткілікті түрде дайын показалистігін көрсетті.

Зерттеудің мақсаты: COVID-19 пандемиясы кезінде әртүрлі елдерде қабылданған шектеу шараларының саны бойынша аурушаңдық пен өлімді зерттеу .

Материалдар мен әдістер: Талдау үшін COVID-19 пандемиясы бойынша әлемдік статистика деректері жинақталған және жүйеленген Our World in data порталының ашық ақпарат көздері пайдаланылды. Деректерді талдау кезеңі 2020 жылдың наурызы - қазіргі уақытқа дейін. Талдауға АҚШ, Ұлыбритания, Италия, Канада, Үндістан, Қытай, Түркия, Израиль, Ресей және Қазақстан сияқты елдер кіреді. Талдау үшін расталған жағдайлардың саны, расталған өлім саны және шектеу шараларының қатаңдық индексі бойынша базалар зерттелді. Спирмен ауру жағдайларына, өлімге және қатаңдық индексіне тәуелділікке корреляциялық талдау жүргізілді.

Нәтижелер және талқылау: Дүниежүзілік денсаулық сақтау ұйымы (ДДҰ) 2020 жылдың 11 наурызында әлемде COVID-19 пандемиясын жариялады. Коронавирус ауруы күрт өсе бастады, әсіресе Еуропа елдерінде вирус туралы ақпарат жеткіліксіз болғандықтан, бүкіл әлем халқы арасында дүрбелең тудырды. Аурушаңдықтың жоғарылауынан басқа, өлім-жітім деңгейі де артты. 2020 жылдан бастап көптеген елдерде шектеу шаралары енгізілді. Енгізілген шаралардың тиімділігін бірден бағалау қиын болды. 2 жылдан кейін қатаңдық индексі жасалды, онда елдердегі барлық шектеу шаралары ескерілді.

Корреляциялық талдау 18.04.2020 ж. ауру мен өлім жағдайларын талдаудың күшті корреляциялық байланысы бар екенін көрсетті r=0,732 (айырмашылықтар статистикалық маңызды R=0,002), ал корреляциялық байланыс қатаңдық индексі мен өлім жағдайларының корреляциялық байланысы әлсіз және статистикалық маңызды емес байланысқа ие (r=-0,067, p=0,814). Қатаңдық индексі мен жағдайлардың корреляциялық талдауы да корреляциялық байланысқа ие емес (r=0,036, p=0,899).

Қорытынды: COVID-19 пандемиясы кезіндегі сырқаттанушылық, өлім-жітім және шектеу шараларының байланысын талдау пандемия кезінде қабылданған шектеу шаралары мен зерттелетін елдердегі аурулар мен өлім деңгейі арасында корреляциялық байланыстың жоқтығын көрсетті. 2020 және 2022 жылдардағы ауру мен өлім деңгейі арасында тікелей және күшті корреляциялық байланыс бар.

Түйінді сөздер: COVID-19 жиілігі, COVID-19 өлімі, шектеу шаралары, корреляциялық талдау.

Introduction

On March 11, 2020, the World Health Organization recognized the outbreak of a new coronavirus disease in Central China as a pandemic and assigned the official name to the infection - COVID-19, calling on all countries to implement not only treatment, but also the immediate implementation of organizational issues [23].

The pandemic of the new coronavirus infection COVID-19 has confronted the healthcare system with the need to quickly resolve issues of organizing medical care for an increasing flow of patients. In accordance with modern realities, the development and improvement of outpatient medical organizations is one of the main elements of the strategic program for restructuring the healthcare system [4].

The scale of the pandemic showed that not a single state has sufficiently demonstrated a high level of readiness to quickly respond and implement measures to reduce the outbreak of infection; in addition, the pandemic has negatively affected the economic development of countries [1].

The study of morbidity and mortality from COVID-19 is an important indicator of the effectiveness of measures taken both in the field of medical treatment and prevention, and in political governance [2].

Aim of the study: To study morbidity and mortality in terms of the number of restrictive measures taken in different countries during the COVID-19 pandemic.

Materials and methods

Open sources of information from the Our portal were used for the analysis. World in Data, where world statistics on the COVID-19 pandemic are collected and systematized. Data analysis period March 2020 to present. The analysis includes countries such as the USA, Great Britain, Italy, Canada, India, China, Turkey, Israel, Russia and Kazakhstan. For the analysis, databases were studied for the number of confirmed cases of the disease, the number of confirmed deaths and the index of severity of restrictive measures.

Spearman correlation analysis was carried out on the dependence of disease cases, deaths and the Severity Index (index of restrictive measures) in the countries studied as of 04.18.2020 at the beginning of the pandemic and 12/31/2022 (date of the last published data on the Severity Index) according to the Our portal World in Data .

Results and discussion

The COVID-19 epidemic caused by the SARS-CoV-2 coronavirus has posed serious challenges for humanity in the modern world. The outbreak of this novel coronavirus has resulted in a global pandemic with severe social, economic and health consequences. For the first time in many decades, the world was faced with such a scale of spread of an infectious disease, which caused widespread unrest and alarm throughout the world [24].

The COVID-19 outbreak has exposed the vulnerabilities of the modern medical system and clearly demonstrated the need for global cooperation in the fight against infectious diseases. Many countries are facing shortages of medical equipment, drugs, and medical personnel, posing serious public health challenges [9].

According to the World Health Organization (WHO), a new coronavirus infection (COVID-19) was reported in Wuhan (Hebei Province, China) in December 2019. Despite the close location of China and Kazakhstan, the first cases of the disease were registered in the Republic of Kazakhstan on March 13, 2020, two citizens of Kazakhstan flew from Germany to the city of Almaty [3].

The World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020. At this time, an increase in incidence was recorded (Figure 1). The incidence of coronavirus began to rise sharply , especially in European countries, despite the fact that there was not enough information about the virus, which caused panic among the population around the world [22]. (picture 1).
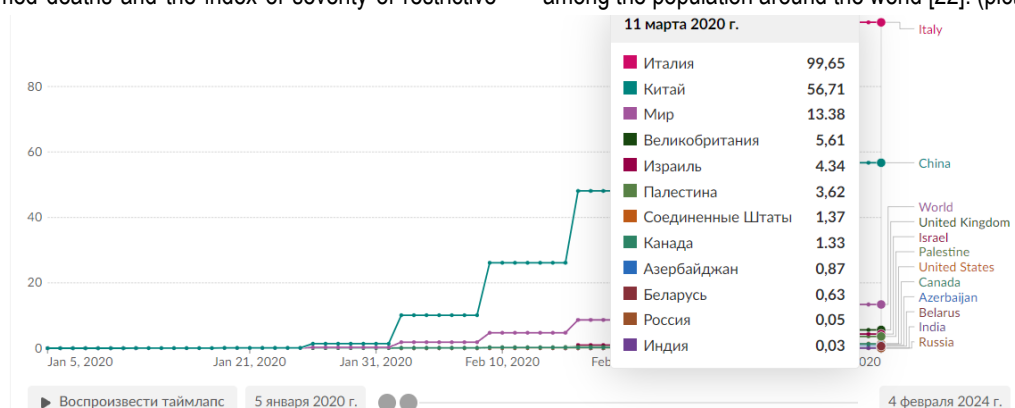

Figure 1. Prevalence of COVID -19 cases during the beginning of the pandemic, as of March 11, 2020.

Some researchers have noted that the high incidence of COVID-19 may be associated with the predominance of the older population, since this group of people is more susceptible to serious forms of the disease. For example, in Italy in January 2020 there was a sharp increase in incidence, which in three months increased from 8 to 99 cases per million people. By the end of 2020, this rate further increased to 34,540 cases per million people [25].

In Kazakhstan, registration of incidence began on March 11, 2020, when 0.31 cases per million people were

recorded. However, by the end of 2020, this figure was already 10,163 cases per million populations [25].

According to the global database on COVID -19 morbidity and mortality, the number of reported cases in different countries varied significantly. In China, the incidence since the beginning of the pandemic has increased from 56.71 cases to 69,603.94 cases per million populations, an increase of 112 times. In Israel, the incidence rate increased from 4.34 cases to 510,298.34, an increase of 117,309.9 times. In all countries, the incidence has only increased over the years (Figure 2).
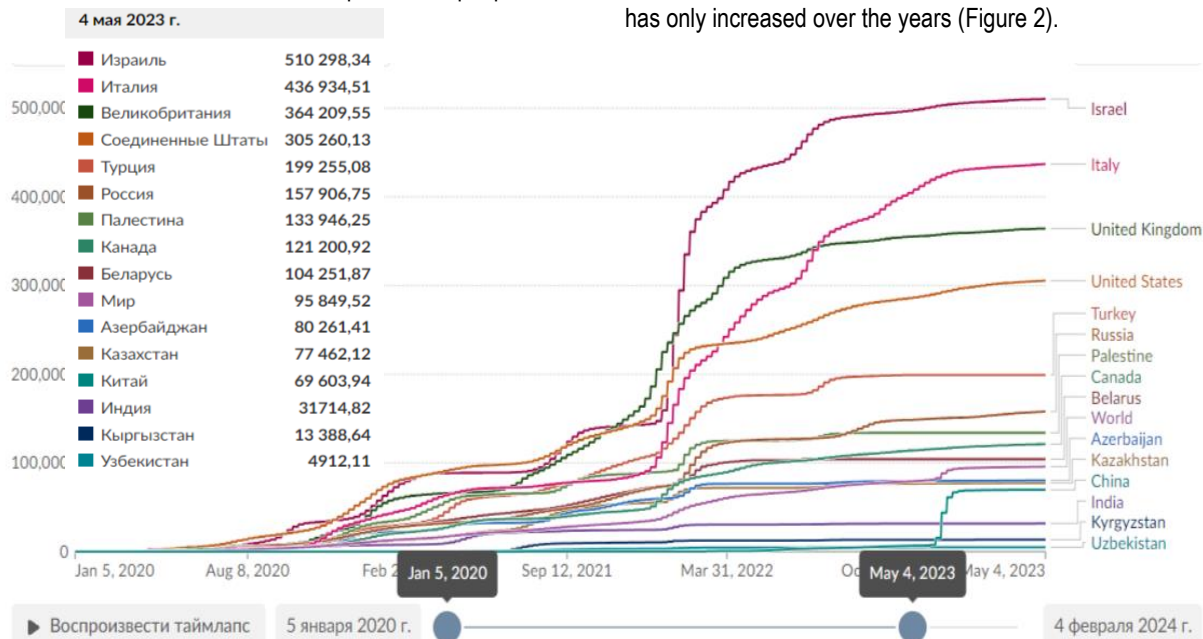

Figure 2. Incidence of COVID-19 in the world, as of May 4, 2023.

Despite the fact that the incidence since the beginning of the pandemic over 3 years has increased by more than 4000 times or more and high incidence rates among the population, on May 5, 2023, WHO head Tedros Adhan Ghebreyesus announced that COVID-19 is no longer a global health emergency, although the danger remains

serious [11, 26, 27]. The pandemic has a "downward trend" but is not over yet [28]. The pandemic period has caused significant damage to the socio-economic development of many countries.

Despite the official end of the pandemic, the incidence of COVID-19 is still being recorded (Figure 3).
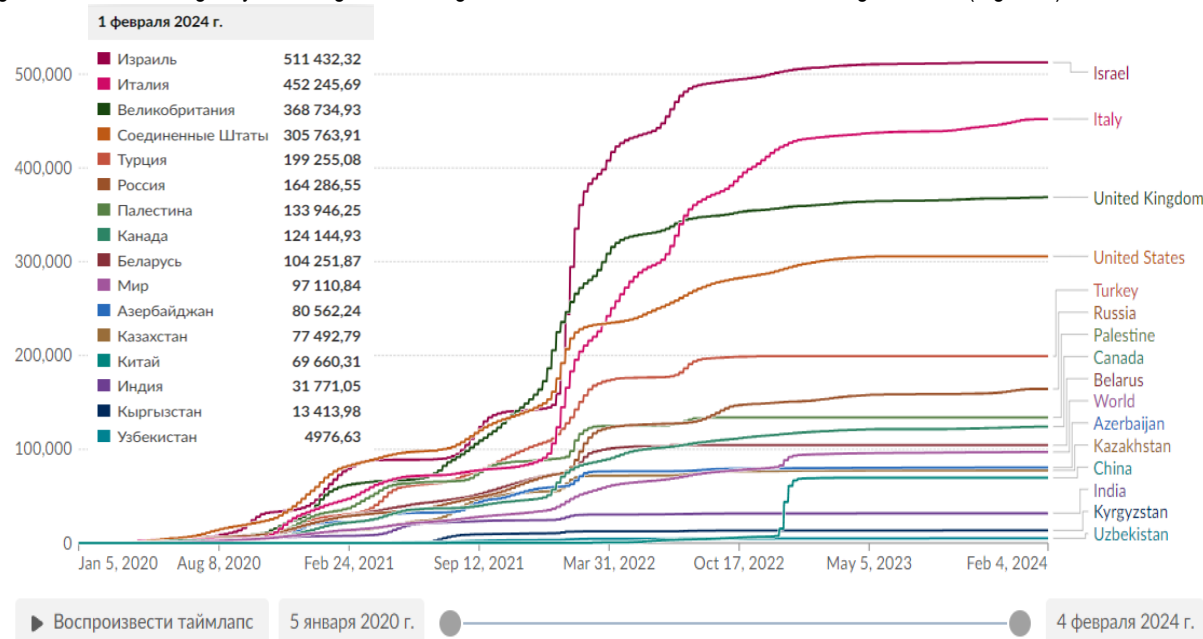

Figure 3. Incidence of COVID-19 in the world, as of February 4, 2024.

According to the literature, men predominated in the overall morbidity and mortality from COVID -19 . The data from our study do not agree with the data of other authors [7, 10, 13,14].

According to Table 2, the ratio of incidence among men and women also differs from literature sources and corresponds to the results obtained in this study. In countries such as Israel, Canada, USA, South Korea, Uzbekistan, Kyrgyzstan, the number of sick women prevails over the number of sick men. At the same time, throughout Kazakhstan, only 38.97% of women fell ill with coronavirus (Table 1) [12].

According to the project " The Sex, Gender and Covid-19" of the Global Health 50/50 organization, the incidence in Kazakhstan by gender has a different ratio, depending on the age of the patients (Figure 4) [12]

Table 1.

Ratio of COVID -19 cases between men and women in different countries.

| A country	Total	Men (%)	Women (%)
Singapore	62476	93.96	6.04
Sri Lanka	3088	81.64	18.36
South Sudan	3074	75.15	24.85
Saudi Arabia	76726	75	25
Pakistan	289832	73.98	26.02
Nigeria	6321	70.04	29.96
Central African Republic	7010	67.56	32.44
India	24766088	61.14	38.86
Kazakhstan	9452	61.03	38.97
Iraq	2330735	61	39
Sudan	28356	60.13	39.87
Nigeria	243639	59.18	40.82
Iran	14991	57	43
China	137353	54.46	45.54
France	29164168	54.19	45.81
Japan	8660712	50.73	49.27
Russia	32	50	50
Norway	1467675	49.16	50.84
Indonesia	5350902	49	51
Czech Republic	3946858	48.35	51.65
Germany	26812700	48.3	51.7
Australia	4097006	48.18	51.82
Sweden	2516145	47.57	52.43
Switzerland	3688878	47.56	52.44
Turkey	13973559	47.54	52.46
Italy	17821706	47.23	52.77
South Korea	18248479	47.01	52.99
Azerbaijan	655068	46.77	53.23
USA	75463792	46.76	53.24
Canada	3734694	46.39	53.61
England	18767685	45.82	54.18
Israel	4171957	45.75	54.25
Hungary	1708339	45.67	54.33
Mongolia	441784	44.69	55.31
Uzbekistan	33	42.42	57.58
Kyrgyzstan	171537	42.41	57.59
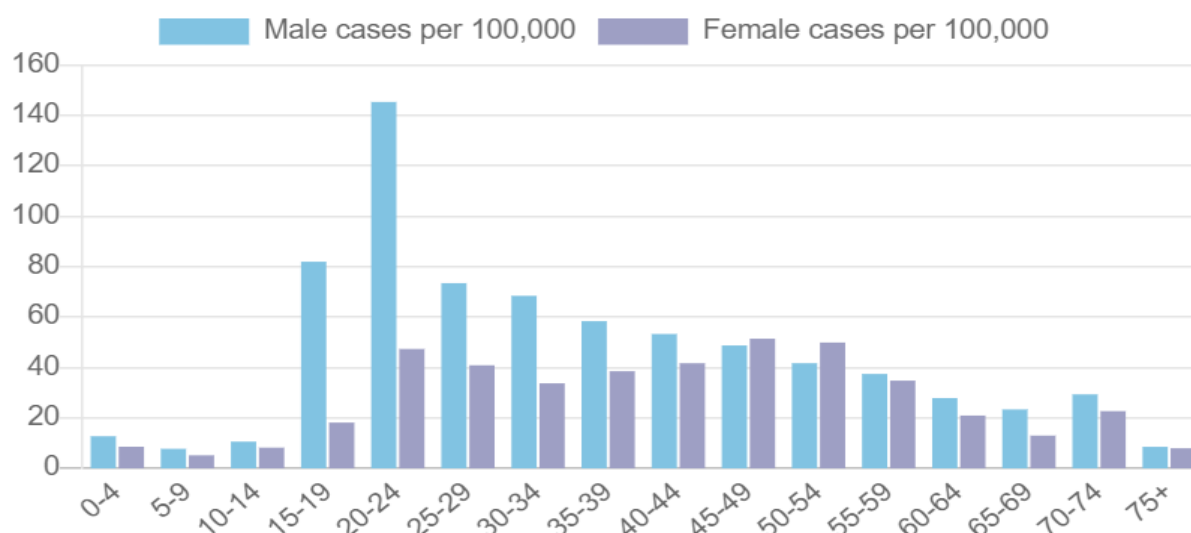
Figure 4. Number of COVID -19 cases by gender and age (per 100,000).

As can be seen in Figure 4, the ratio of cases of the disease under 44 years of age shows the predominance of males in the morbidity structure. After 45 years, the ratio of cases of the disease between men and women levels off. Many authors associate the low incidence and milder course of morbidity in women with the content of female hormones estrogen, and in men a more severe course with the content of testosterone [7, 15, 19, 20].

A study in Canada showed similar results , with the overall incidence being higher in women compared to men, particularly among patients aged 20 to 50 years and over

80 years. They excluded health care workers from the study, and the incidence of women decreased in the sample [17]. The authors also studied the effect of estrogens on morbidity, and obtained results that this sex hormone affects morbidity in women under 50 years of age, during the period of fertile age, after menopause, the hormone content decreases, and the morbidity of women increases, the data is consistent with other studies [5, 6, 8, 10].

The total number of confirmed deaths from COVID-19 per million people is also trending upward, despite the restrictive and preventive measures taken (Table 2).

Table 2.

Mortality from COVID-19, number of cases per million population.

A country	December 31, 2020	December 29, 2021	December 30, 2022	December 31, 2023
China	3.35	4.05	27.35	85.49
India	104.17	338.48	374.47	376.36
Israel	343.11	873.21	1272.73	1344.8
Italy	1213.25	2312.6	3119.51	3308.37
Kazakhstan	137.59	937.47	982.42	983.19
Kyrgyzstan	-	129.7	154.44	154.44
Russia	378.53	2102.21	2718.36	2773.48
Türkiye	1168.29	952.68	1188.39	1188.39
Great Britain	1340.19	2609.42	3189.87	3438.24
United States	1013.69	2402.04	3192.46	3440.28
Uzbekistan	-	29.28	29.34	29.34

The mortality analysis in Table 2 shows mixed data. In some countries, such as China, deaths from coronavirus are recorded even after the end of the pandemic, but at the same time, mortality rates are not critical. In other countries such as Italy, mortality has increased annually and mortality rates are the highest, a similar situation is observed in countries such as the UK and the USA. The mortality rate has shown a slight increase since the end of the pandemic in 2023, but no country has seen a decline in COVID-19 deaths (Table 2).

Coronavirus continues to be a serious problem for Kazakhstan, as well as for many other countries in the world. Since the beginning of the pandemic, the country has faced various challenges in the fight against this virus, including the introduction of restrictive measures, large-

scale vaccination and monitoring of the epidemiological situation.

According to the latest data, cases of infection with new strains of coronavirus , such as Delta and Omicron , have been recorded . This has led to the need for increased measures to prevent the spread of the virus, including increased attention to social distancing measures , the use of masks and hygiene measures [16] .

Vaccination remains a key tool in the fight against the pandemic in Kazakhstan. The country continues to actively vaccinate its population by providing access to various types of vaccines and conducting campaigns to encourage the population to vaccinate [29] .

The country's authorities are also focusing on monitoring the epidemiological situation in order to quickly

respond to any changes and take appropriate measures to prevent the spread of the virus [18] .

Analysis of restrictive measures in the Severity Index shows that in different countries restrictive measures varied in time and number of measures. For example, in Kazakhstan in April 2020, the Severity Index was 92 out of 100, by September of the same year it dropped to 75 and remained at this level until the end of 2020. During 2021, the Strict Index varied from 75 to 62. And from April 2022, it began to actively decline from 22 at the beginning of the year to 5 at the end of 2022. Since 2023, restrictive measures have been lifted (Figure 5).
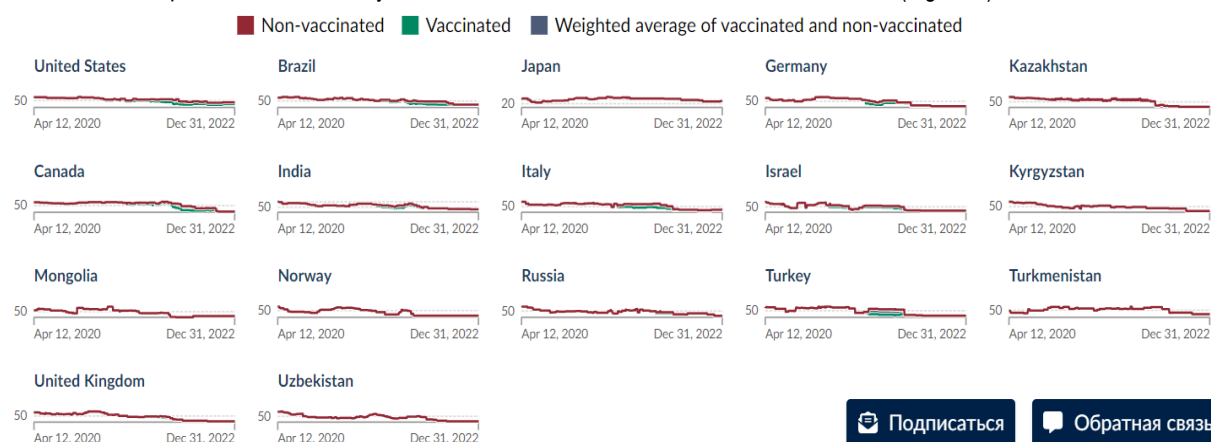

Figure 5. COVID-19 restrictive measures - Strictness index on a scale from 0 to 100.

An analysis of other countries on restrictive measures shows that in countries with high mortality rates from COVID-19, restrictive measures were not completely lifted even after the end of the pandemic.

In the United States, since the beginning of the pandemic, restrictive measures were not completely lifted until the end of the pandemic. In 2020, restrictive measures amounted to 72 and until the end of the year varied from 66 to 72. In 2021, they ranged from 71 and decreased to 58, while due to an active vaccination campaign, restrictive measures for vaccinated people were reduced to 46, and in 2022 year ranged from 57 to 37 by the end of the year.

In Italy, since the beginning of the pandemic, the severity index was 93, in the middle of the year it decreased to 62 and by the end of the year it increased again to 82 for 2020. From 2021, from 82 decreased to 73 for the unvaccinated, while for the population who received the vaccine, the requirements for restrictive measures were reduced and amounted to 47. In 2022, from 73, by the middle of the year in June it decreased to 22 and remained at this level until the end of the year.

A correlation analysis of the relationship between morbidity, mortality and the severity index was carried out in 15 countries according to the Our world in data platform. The analysis included data from such countries as Brazil, Canada, Germany, India, Israel, Italy, Japan, Kazakhstan, Kyrgyzstan, Mongolia, Russia, Turkey, Great Britain, the United States, and Uzbekistan. For this analysis, data were analyzed for April 18, 2020 (after COVID-19 was declared a pandemic) and December 31, 2022 (the latest stringency index data is only available for this period). Data on morbidity, mortality and severity index are presented in Table 3.

Table 3.

Data on morbidity, mortality and severity index for the studied period.

Country or region	Index strogosti (04.18.2020) From 0 to 100	Index strogosti (December 31, 2022) From 0 to 100	Number of cases (04.18.2020) per million people	Number of cases (December 31, 2022) per million people	Number of deaths (04.18.2020) per million people	Number of deaths (December 31, 2022) per million people
Brazil	74.54	22.22	22,667.06	167,775.53	675.24	3217.37
Canada	74.54	5.56	4229.93	116,407.83	243.67	1259.18
Germany	76.85	11.11	3637.25	446,707.54	119.46	1987.98
India	100	28.7	4621.44	31,525.51	71.82	374.47
Israel	91.67	14.81	28,007.30	503,408.19	182.14	1272.73
Italy	93.52	25	5,473.64	424,484.69	609.24	3119.51
Japan	47.22	33.33	688.49	228,043.71	12.88	450.28
Kazakhstan	92.13	5.56	7,307.35	76,926.55	106.97	982.42
Kyrgyzstan	92.13	11.11	0	13,340.38	0	154.44
Mongolia	63.89	11.11	92.1	296,410.66	0	628.54
Russia	85.19	11.11	8,395.92	150,395.92	147.59	2718.36
Türkiye	77.78	11.11	9,147.44	199,255.08	98.24	1188.39
Great Britain	79.63	5.56	7688.11	357,864.28	871.83	3189.87
United States	72.69	37.04	21,873.09	292,706.07	630.47	3192.46
Uzbekistan	90.74	5.56	0	4831.17	0	29.34

Correlation analysis showed that the analysis of cases of illness and death for 04/18/2020 has a strong correlation r = 0.732 (the differences are statistically significant p = 0.002), while the correlation relationship between the Severity Index and death cases is weak and statistically not significant relationship (r = -0.067, p = 0.814). Correlation analysis of the Severity Index and disease cases also do not have a correlation (r=0.036, p=0.899).

Correlation analysis showed that the analysis of cases of illness and death for December 31, 2022 has a moderate correlation r = 0.582 (the differences are statistically significant p = 0.023), while the correlation between the Severity Index and deaths has a weak and statistically insignificant relationship (r =0.217, p =0.814). Correlation analysis of the Severity Index and disease cases also do not have a correlation (r=0.294, p=0.288).

Conclusions

Analysis of the relationship between morbidity, mortality and restrictive measures during the COVID-19 pandemic showed the absence of a correlation between the restrictive measures taken during the pandemic and the level of morbidity and mortality in the countries studied. There is a direct and strong correlation between the level of diseases and deaths for 2020 and 2022.

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