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Original article

Pandemic and policy effects on hepatitis C and diabetes: Insights from Kazakhstan using interrupted time series analysis

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Abstract. *Background and aim:* This study assesses the impact of the COVID-19 pandemic and compulsory social health insurance system (CSHIS) on hepatitis C and diabetes dispanserization rates in Kazakhstan from 2018 to 2023, using Interrupted Time Series (ITS) analysis. *Methods:* Dispanserization data for hepatitis C and diabetes were collected for Kazakhstan from 2018 to 2023. The effect of COVID-19 lockdown was analyzed using four models: unadjusted lockdown effect, adjusted for monthly population size, adjusted for CSHIS, and adjusted for both. *Results:* The unadjusted ITS analysis revealed a significant negative impact of the COVID-19 lockdown on diabetes dispanserization rates (estimate = −8 511.2, SE = 1 883.7, $p < 0.001$), but not for hepatitis C (estimate = −812, SE = 778, $p = 0.3$). There was a significant upward trend over time for both conditions. After adjusting for population size and CSHIS implementation, the negative lockdown effect remained significant for both hepatitis C (estimate =−3,590, SE = 1,100, $p < 0.01$) and diabetes (estimate = −10,500, SE = 3,210, $p < 0.01$), while the effect of CSHIS remained insignificant. *Conclusions:* The COVID-19 pandemic had a significant negative impact on dispanserization rates for both hepatitis C and diabetes in Kazakhstan. In contrast, our analysis demonstrates that the dispanserization rates for these chronic diseases were not significantly affected by the implementation of CSHIS. These findings emphasize the importance of implementing policies that can prevent the disruption of essential healthcare services during pandemics or other crises, ensuring that patients continue to receive the medical care they need. (www.actabiomedica.it)

Key words: hepatitis c, diabetes, interrupted time series, Kazakhstan, social health insurance, COVID-19, lockdown, health policy impact, chronic disease trends

Introduction

With chronic diseases on the rise and placing increasing pressure on healthcare systems, they have become a critical global public health issue. The World Health Organization (WHO) estimates that 422 million people worldwide had diabetes in 2014, with type 2 being most prevalent (1). As of 2021, diabetes strikes approximately 537 million adults aged between ages 20 and 79 (2) — reported by the International Diabetes Federation (IDF). Diabetes, particularly type 2, has reached pandemic levels. According to the WHO, diabetes cases worldwide are on the rise and are expected to keep increasing due to factors like aging populations, urbanization, and shifts in lifestyle (1). The IDF also suggests that by 2045, one in eight adults will have

diabetes (2). Furthermore, diabetes caused 1.5 million deaths in 2019, 48% of which occurred before the age of 70 (1). Hepatitis C, a persistent viral infection of the liver, is a significant contributor to liver-related morbidity and mortality worldwide. As a result of population growth and aging, there was expected to record 6.2 million new Hepatitis C virus infections, and 0.54 million Hepatitis C virus-related deaths worldwide in 2019 (3). The growing number of diabetes and hepatitis C cases in Kazakhstan is straining the country's healthcare resources and making it difficult to meet the increasing demand for medical care. The number of non-insulin-dependent diabetes (E.11) cases rose from 363 728 in 2018 to 671 356 in 2021, with the incidence rate increasing from 1 962.7 per 100 000 to 3 510.2 per 100 000 population over the same period (4). As of September 25, 2020, the "Viral Hepatitis" Register recorded 29 264 individuals diagnosed with chronic hepatitis C (CHC) in Kazakhstan (5). In early 2020, the COVID-19 pandemic exacerbated the healthcare burden and had a significant impact on public health infrastructures worldwide, which were unprepared for an infectious respiratory pandemic, including in Kazakhstan (6). A health emergency of this scale not only affected the population directly through infections and fatalities but also indirectly by disrupting healthcare access, delaying treatments, and altering lifestyles, leading to an increase in chronic diseases. A mortality analysis shows a clear association between insufficient healthcare resources and negative outcomes for patients (7). As of December 2023, the WHO has reported 1,502,857 confirmed COVID-19 cases and 19,072 deaths in Kazakhstan (8). The country faced unique challenges in combating the spread of the virus while ensuring the continuity of care for non-COVID-related illnesses, including chronic diseases like diabetes and hepatitis C during a major healthcare system funding reform that was initiated in 2020. In January 2020, Kazakhstan introduced the Compulsory Social Health Insurance System (CSHIS) that aimed to provide more equitable access to healthcare services and ensure financial sustainability for the country's public health system (9). Before the introduction of CSHIS, Kazakhstan's healthcare system was insufficiently funded under universal healthcare coverage (10). This underfunding led to high out-of-pocket payments, limited access to healthcare services, and a low quality of medical care (11). For instance, a national study of 78 hospitals revealed that hospitals in Kazakhstan were not highly compliant with the WHO-recommended "Healthcare-Associated Infections (HAI) surveillance" component (12). With an average score of just 1.14 out of 5, 65% of the hospitals lacked an effective HAI surveillance system (12). The CSHIS brought a major shift towards a more inclusive, insurance-based healthcare model that was intended to make healthcare more accessible and affordable across Kazakhstan. However, the unexpected arrival of COVID-19 added a layer of complexity, stretching the system's ability to deliver on its goals. Considering this, it's critical to explore how both the pandemic and the CSHIS have influenced the continuous medical monitoring of patients with chronic diseases, such as diabetes and hepatitis C. Dispensarization, a key component of Kazakhstan's healthcare system, involves routine outpatient monitoring of patients with chronic conditions. It plays a crucial role in the effective management of these diseases by ensuring regular health assessments and timely interventions. Specifically, dispensarization is a system of measures designed to maintain public health, prevent the onset and progression of chronic diseases, reduce the frequency of exacerbations, and mitigate the risk of complications, disability, and mortality, ultimately enhancing the quality of life. In the context of this study, the dispensarization rate refers to the number of patients diagnosed with hepatitis C or diabetes who are enrolled in this outpatient care program within the national healthcare system. This study aims to assess the impact of the COVID-19 pandemic and the introduction of the compulsory social health insurance system (CSHIS) on hepatitis C and diabetes dispanserization rates in Kazakhstan from 2018 to 2023, using Interrupted Time Series (ITS) analysis.

Materials and Methods

Data sources

The data for hepatitis C and diabetes dispanserization rates in absolute numbers in Kazakhstan were obtained upon official request from the of the National

Research Center for Health Development of the Republic of Kazakhstan. This dataset provides monthly hepatitis C and non-insulin dependent type diabetes dispanserization counts from January 2018 to December 2023, using the following codes from the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM): B18.2 and E11-E11.9. This data was specifically chosen to analyze the number of patients who were enrolled in regular medical monitoring. Monthly data was obtained and combined. Figure 1 presents the hepatitis C dispanserization dynamics, illustrating an increase in the number of hepatitis C dispanserization from 2018 to 2023. Figure 2 represents the monthly number of diabetes dispanserization rate, also reflecting a steady increase from 2018 to 2023.

Analysis method

ITS analysis was used to assess the impact of the COVID-19 pandemic and CSHIS reintroduction

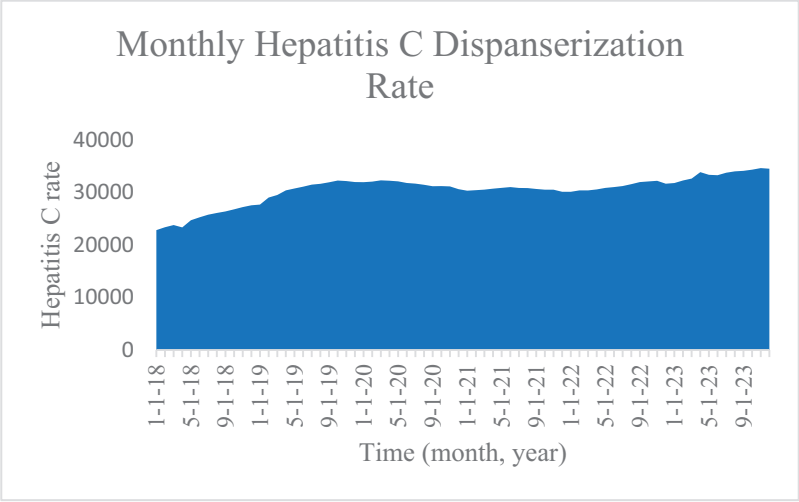

Figure 1. Monthly Hepatitis C Dispanserization Rate in Kazakhstan in Absolute Numbers (2018-2023)

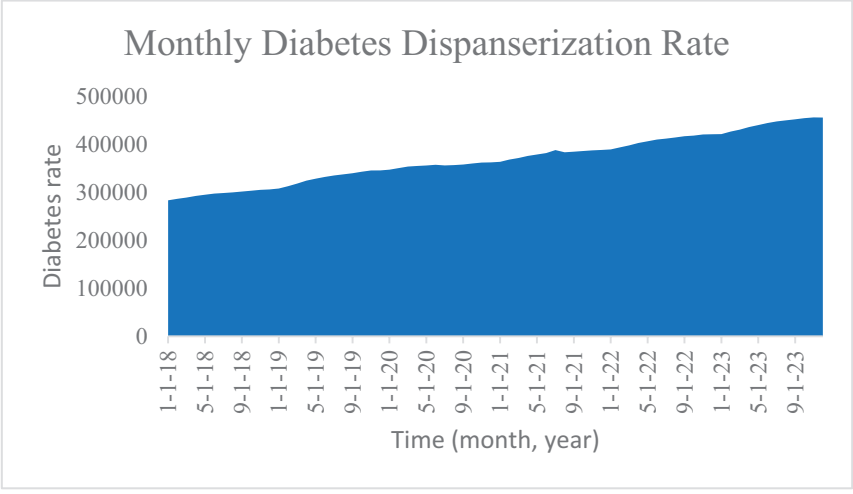

Figure 2. Monthly Diabetes Dispanserization Rate in Kazakhstan in Absolute Numbers (2018-2023)

on hepatitis C and diabetes dispanserization rates in Kazakhstan. Interrupted time series analysis is a statistical method for evaluating the effects of interventions or external events on time-series data. It enables the analysis of both immediate and gradual shifts in the outcome variable following the intervention, specifically the onset of the pandemic and the reintroduction of CSHIS in Kazakhstan.

Data preprocessing

For the ITS analysis, we developed three key variables: the "lockdown effect" variable, the "trend" variable, and the "CSHIS effect" variable. The "lockdown effect" variable marks the intervention date, which is set based on the lockdown declaration in Kazakhstan on March 19, 2020. Thus, the corresponding "lockdown effect" date is March 2020. The "trend" variable measures how closely each monthly variable aligns with this intervention date. The "CSHIS effect" variable similarly marks the intervention date associated with the implementation of CSHIS in Kazakhstan on January 1, 2020, making January 2020 the "CSHIS effect" date. Consequently, we collected approximately three years of data prior to the expected impacts of the COVID-19 lockdown and compared these trends with nearly three years of data following the lockdown.

Statistical analysis

All data processing and statistical analyses were conducted using RStudio (Version 4.3.2; RStudio, Inc., Boston, MA, USA). Linear regression analysis was performed utilizing the 'lm' function. The unadjusted impact of the COVID-19 lockdown on hepatitis C and Diabetes dispanserization rates in Kazakhstan was evaluated based on the "lockdown effect" and "trend" variables. For the adjusted impact, the analysis accounted for the country's population size, incorporating the "lockdown effect," "trend" variables, and the monthly population data provided by the Statistical Committee of the Republic of Kazakhstan. Additionally, to assess the impact adjusted for the reintroduction of the Compulsory Social Health Insurance System (CSHIS), the model included the "CSHIS effect" alongside the "lockdown effect" and "trend" variables. The final model encompassed all these variables. Predictions of hepatitis C and diabetes dispanserization rates based on intervention dates were generated using the 'predict' function in conjunction with the 'lm' function. Scatter plots were created using the 'plot' function. These functions are native to base R, eliminating the need for additional packages.

Results

Unadjusted Impact of the COVID-19 Lockdown on Hepatitis C and Diabetes Dispanserization Rates in Kazakhstan (2018-2023)

The ITS analysis evaluated the impact of the COVID-19 lockdown announcement on the monthly hepatitis C dispanserization rate in Kazakhstan from January 2018 to December 2023. The unadjusted regression model results, as presented in Table 1, reveal an intercept, representing the baseline monthly hepatitis C dispanserization rate when other variables are held constant, estimated at 29 924 (SE = 422, $p < 0.001$). The coefficient for the COVID-19 lockdown effect, indicating the change in the monthly hepatitis C dispanserization rate post-lockdown announcement, was estimated at -812 (SE = 778, $p = 0.3$). This suggests a statistically insignificant decrease in monthly hepatitis C dispanserization rates following the COVID-19 lockdown announcement. Additionally, the coefficient

Table 1. Unadjusted linear regression model results examining the impact of the COVID-19 lockdown on hepatitis C and diabetes dispanserization in Kazakhstan (2018-2023)

Variables	Estimate	SE[1]	*P-value*
Hepatitis C			
Hepatitis C rate	29 924	422	**<0.001**
Lockdown effect	-812	778	0.3
Trend	117	18	**<0.001**
Diabetes			
Diabetes rate	350 966.6	1021.3	**<0.001**
Lockdown effect	-7 511.2	1 883.7	**<0.001**
Trend	2 508.4	43.5	**<0.001**

[1]SE – standard error

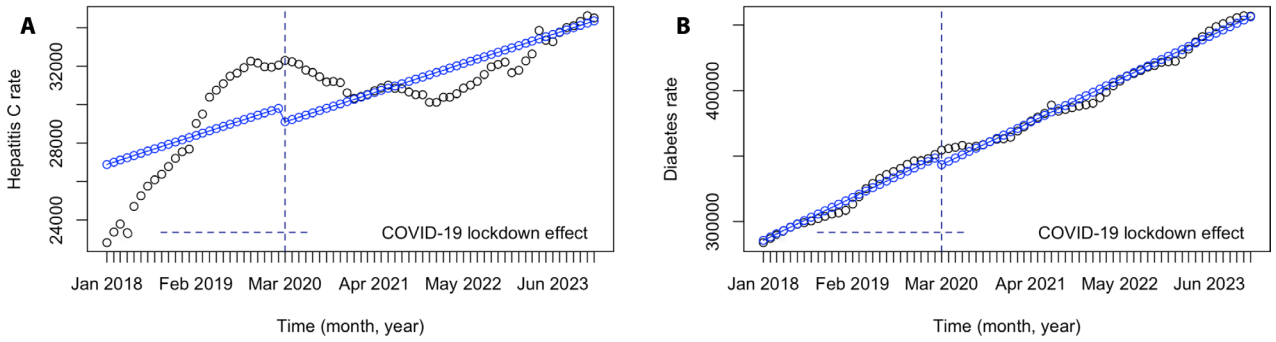

Figure 3. COVID-19 Lockdown Effect on A) Hepatitis C Dispanserization Rates in Kazakhstan (2018-2023); B) Diabetes Dispanserization Rates in Kazakhstan (2018-2023)

for the trend variable was estimated at 117 (SE = 18, p < 0.001), indicating a significant increasing trend in hepatitis C dispanserization rates over time. Subsequently, the analysis extended to evaluate the impact of the COVID-19 lockdown on monthly diabetes dispanserization rates within the same timeframe. The findings were similar to those observed for hepatitis C. The unadjusted regression model estimated the intercept for diabetes dispanserization rates at 350 966.6 (SE = 1 021.3, p < 0.001), representing the baseline rate. The coefficient for the lockdown effect, reflecting the change in monthly diabetes dispanserization rates post-lockdown, was estimated at -7 511.2 (SE = 1 883.7, p < 0.001), indicating a decrease in rates, though it was statistically insignificant. Additionally, the trend variable's coefficient was estimated at 2 508.4 (SE = 43.5, p < 0.001), signifying a significant positive trend in diabetes dispanserization rates over time.

Figure 3 presents the visual representation of the ITS analysis of monthly hepatitis C and diabetes dispanserization rates from 2018 to 2023. A decrease in hepatitis C and Diabetes dispanserization rates is observed precisely at the "lockdown effect" point; however, an upward trend is evident afterward.

The Impact of the COVID-19 Lockdown on Hepatitis C Rate in Kazakhstan Adjusted to the Kazakhstan Population

As the second step of the analysis, we adjusted the monthly hepatitis C dispanserization rates for each month, taking population size into account, as shown in Table 2. The intercept, representing the baseline hepatitis C dispanserization rate with all other variables held constant, was estimated at 246 000 (SE = 35 000, p < 0.001). The coefficient for the COVID-19 lockdown effect, reflecting the change in the hepatitis C dispanserization rate after the lockdown announcement, was -2 970 (SE = 727, p < 0.001). This finding highlights a significant decline in monthly hepatitis C dispanserization rates following the lockdown. Furthermore, the coefficient for the trend variable was 477 (SE = 61.5, p < 0.001), suggesting a notable upward trend in dispanserization rates over time.

Table 2. Linear Regression Model Results Examining the Impact of the COVID-19 Lockdown on Hepatitis C and Diabetes Dispanserization Rates in Kazakhstan Adjusted to the Country Population

Variables	Estimate	SE[1]	*P-value*
Hepatitis C			
Hepatitis C rate	246 000	35 800	**<0.001**
Lockdown effect	-2 970	727	**<0.001**
Trend	477	61.5	**<0.001**
Country population	-0.0115	0.0019	**<0.001**
Diabetes			
Diabetes rate	579 000	104 000	**<0.001**
Lockdown effect	-9 790	2 110	**<0.001**
Trend	2 890	178	**<0.001**
Country population	-0.0121	0.00552	**0.032**

[1]SE – standard error

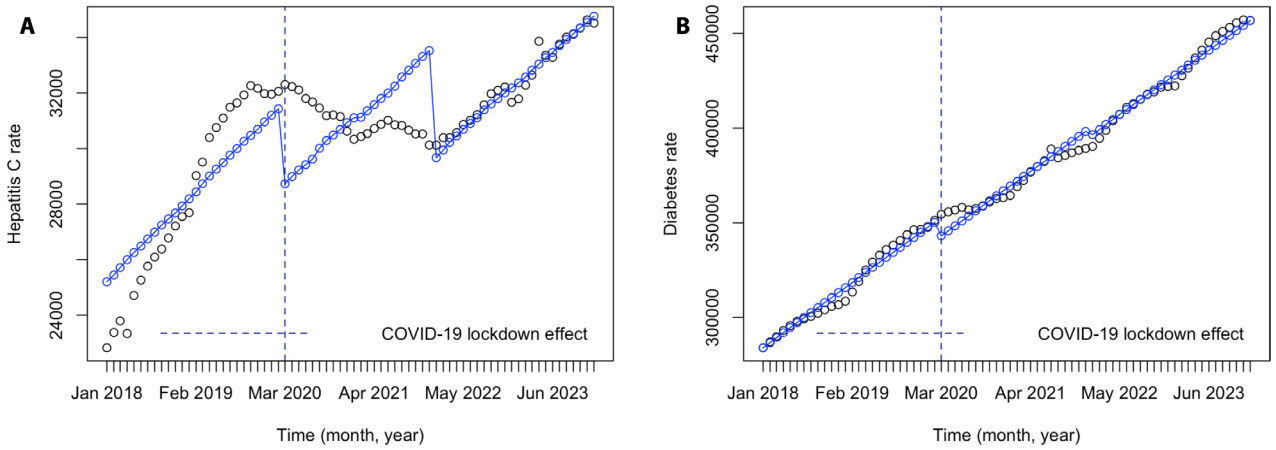

Figure 4. COVID-19 Lockdown Effect on A) Hepatitis C Dispanserization Rates in Kazakhstan Adjusted to the Country Population Size (2018-2023); B) Diabetes Dispanserization Rates in Kazakhstan Adjusted to the Country Population Size (2018-2023)

The population effect coefficient was -0.0115 (SE = 0.0019, p < 0.001), indicating that as the population size increased, there was a slight downward trend in monthly hepatitis C dispanserization rates. In the subsequent analysis, we examined the impact of the COVID-19 lockdown on monthly diabetes dispanserization rates, also adjusted for the country's population size over the same period. The results mirrored those observed for hepatitis C, revealing that both the lockdown and population size had negative effects on the diabetes dispanserization rate. The adjusted regression model estimated the intercept for diabetes dispanserization rates at 579 000 (SE = 104 000, p < 0.001), representing the baseline rate. The coefficient for the lockdown effect, indicating changes in monthly diabetes dispanserization rates post-lockdown, was -9 790 (SE = 2 110, p < 0.001), signaling a significant decrease in rates. The trend variable's coefficient was 2 890 (SE = 178, p < 0.001), indicating a significant positive trend in diabetes dispanserization rates over time. Lastly, the population effect coefficient was -0.0121 (SE = 0.00552, p = 0.032), showing a slight downward trend in monthly diabetes dispanserization rates as the population size increased.

Figure 4 illustrates the ITS analysis of monthly hepatitis C and Diabetes dispanserization rates in Kazakhstan from 2018 to 2023, with adjustments for the monthly population size. The analysis reveals a noticeable decline in the hepatitis C dispanserization rate at the onset of the 'lockdown effect,' followed by a fluctuating upward trend over time. Similarly, a slight decrease is evident in the Diabetes dispanserization rate at the time of the 'lockdown effect,' which is subsequently followed by a steady and continuous increase.

Table 3. Linear Regression Model Results Examining the Impact of the COVID-19 Lockdown on Hepatitis C and Diabetes Dispanserization Rates in Kazakhstan Adjusted to the CSHIS Effect

Variables	Estimate	SE[1]	*P-value*
Hepatitis C			
Hepatitis C rate	29 643.7	437.4	**<0.001**
Lockdown effect	-2 920.1	1 317.2	**0.03**
Trend	110.4	17.9	**<0.001**
CSHIS effect	2530.8	1 289.9	0.054
Diabetes			
Diabetes rate	350 665.8	1082.8	**<0.001**
Lockdown effect	-9 772.3	3 261.2	**<0.01**
Trend	2 501.5	44.4	**<0.001**
CSHIS effect	2 715	3 193.4	0.3982

[1]SE – standard error

The Impact of the COVID-19 Lockdown on Hepatitis C Rate in Kazakhstan Adjusted to the CSHIS Effect

As the third step of the analysis, we adjusted the monthly hepatitis C dispanserization rates to account for the "CSHIS effect" following the implementation of CSHIS in January 2020, as shown in Table 3. The

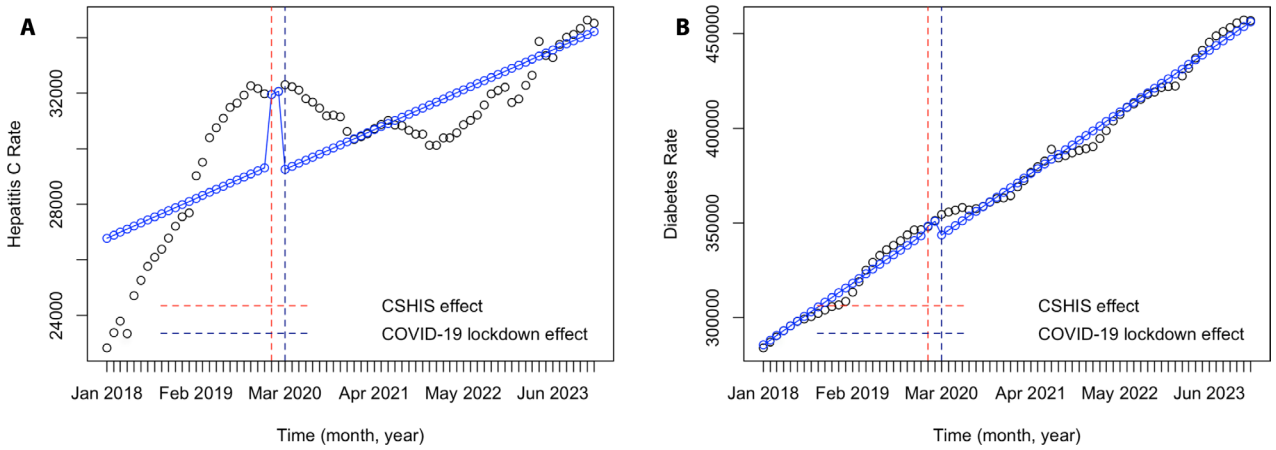

Figure 5. COVID-19 Lockdown Effect on A) Hepatitis C Dispanserization Rates in Kazakhstan Adjusted to the CSHIS effect; B) Diabetes Dispanserization Rates in Kazakhstan Adjusted to the CSHIS effect

intercept, representing the baseline monthly hepatitis C dispanserization rate when all other variables are held constant, was estimated at 29 643.7 (SE = 437.4, $p < 0.001$). The coefficient for the COVID-19 lockdown effect, reflecting the change in monthly hepatitis C dispanserization rates post-lockdown announcement, was estimated at -2 920.1 (SE = 1,317.2, $p = 0.03$), indicating a significant decline in rates following the lockdown. Additionally, the coefficient for the trend variable was estimated at 110.4 (SE = 17.9, $p < 0.001$), suggesting a notable upward trend in dispanserization rates over time. The coefficient for the CSHIS effect was estimated at 2,530.8 (SE = 1 289.9, $p = 0.054$), indicating a near-significant increase in rates associated with the CSHIS implementation.

In the subsequent analysis, we examined the impact of the COVID-19 lockdown on monthly diabetes dispanserization rates, also adjusted for the "CSHIS effect" over the same period. The results mirrored those observed for hepatitis C, revealing that although not statistically significant the CSHIS implementation had a positive impact on the diabetes dispanserization rates. The adjusted regression model estimated the intercept for diabetes dispanserization rates at 350 665.8 (SE = 1 082.8, $p < 0.001$), representing the baseline rate. The coefficient for the lockdown effect, indicating changes in monthly diabetes dispanserization rates post-lockdown, was -9 772.3 (SE = 3 261.2, $p < 0.01$), signaling a significant decrease in rates. The trend variable's coefficient was 2,501.5 (SE = 44.4, $p < 0.001$), indicating a significant positive trend in diabetes dispanserization rates over time. Lastly, the CSHIS effect coefficient was 2 715 (SE = 3 193.4, $p = 0.3982$), indicating an increase in rates associated with the CSHIS implementation, although not statistically significant.

Figure 5 illustrates the ITS analysis of monthly hepatitis C and diabetes dispanserization rates from 2018 to 2023, adjusted for the CSHIS effect. Notably, there is a significant increase in hepatitis C dispanserization rates beginning in January 2020, coinciding with the implementation of CSHIS. This rise is followed by a marked decrease at the onset of the "lockdown effect," with a subsequent downward trend observed thereafter. Similarly, a slight increase in diabetes dispanserization rate in January 2020 at the "CSHIS effect" time is evident, followed by a slight decrease at the time of the 'lockdown effect,' which is subsequently followed by a steady and continuous increase.

The Impact of the COVID-19 Lockdown on Hepatitis C Rate s in Kazakhstan Adjusted to the Kazakhstan Population and CSHIS Effect

The final model illustrates the monthly adjusted hepatitis C dispanserization rates, accounting for the effects of the CSHIS implementation, the COVID-19 lockdown, and the monthly population

Table 4. Linear Regression Model Results Examining the Impact of the COVID-19 Lockdown on Hepatitis C and Diabetes Dispanserization Rates in Kazakhstan Adjusted to the Country Population and CSHIS Effect

Variables	Estimate	SE[1]	*P-value*
Hepatitis C			
Hepatitis C rate	238 000	37 400	**<0.001**
Lockdown effect	-3 590	1 100	**<0.01**
Trend	462	64.7	**<0.001**
CSHIS effect	838	1 120	0.45
Country population	-0.0111	0.0019	**<0.001**
Diabetes			
Diabetes rate	570 000	109 000	**<0.001**
Lockdown effect	-10 500	3 210	**<0.01**
Trend	2 870	188	**<0.001**
CSHIS effect	932	3 250	0.77
Country population	-0.0117	0.006	**0.047**

[1]SE – standard error

size, as detailed in Table 4. The intercept, representing the baseline monthly hepatitis C dispanserization rate when all other variables are held constant, is estimated at 238 000 (SE = 37 400, p < 0.001). The coefficient for the COVID-19 lockdown effect, which indicates the change in monthly hepatitis C dispanserization rates following the lockdown announcement, is −3 590 (SE = 1 100, p < 0.01). This result suggests a significant reduction in dispanserization rates immediately after the lockdown. Furthermore, the coefficient for the centering variable is 462 (SE = 64.7, p < 0.001), reflecting a significant upward trend in dispanserization rates over time. The effect of CSHIS was not statistically significant, with a coefficient of 838 (SE = 1 120, p = 0.45). Lastly, the coefficient for the monthly population variable is estimated at -0.0111 (SE = 0.0019, p = 0.001), indicating a minor yet significant impact on dispanserization rates. In the subsequent analysis, we examined the impact of the COVID-19 lockdown on monthly diabetes dispanserization rates, also adjusted for the "CSHIS effect" and monthly population size over the same period. The results mirrored those observed for hepatitis C, revealing that although not statistically significant the CSHIS implementation had a positive impact, and population size had a significant negative impact on the diabetes dispanserization rates. The adjusted regression model estimated the intercept for diabetes dispanserization rates at 570 000 (SE = 109 000, p < 0.001), representing the baseline rate. The coefficient for the lockdown effect, indicating changes in monthly diabetes dispanserization rates post-lockdown, was -10 500 (SE = 3 210, p < 0.01), signaling a significant decrease in rates. The trend variable's coefficient was 2 870 (SE = 188, p < 0.001), indicating a significant positive trend in diabetes dispanserization rates over time. The CSHIS effect coefficient was 932 (SE = 3 250, p = 0.77), indicating an increase in rates associated with the CSHIS implementation, although not statistically significant. Lastly, the coefficient for the monthly population variable is estimated at -0.0117 (SE = 0.006, p = 0.047), indicating a minor yet significant impact on dispanserization rates.

Figure 6 presents the visual representation of the ITS analysis of monthly hepatitis C and diabetes dispanserization rates from 2018 to 2023, adjusted for the effects of CSHIS implementation and population size. A notable increase in hepatitis C dispanserization rates is observed starting from January 2020, coinciding with the implementation of CSHIS. This is followed by a sharp decline immediately after the COVID-19 lockdown announcement, with a subsequent fluctuating upward trend. Similarly, a slight increase in diabetes dispanserization rates is evident in January 2020, corresponding with the "CSHIS effect," followed by a slight decrease during the "lockdown effect" period, which is then followed by a steady and continuous increase.

Discussion

The country population health was affected by COVID-19 pandemic and the implementation of the CSHIS system. This study aimed to quantitively assess the impact of the COVID-19 pandemic and the CSHIS implementation on hepatitis C and diabetes dispanserization rates (2018 to 2023) in Kazakhstan. The unadjusted ITS analysis shows that the COVID-19 lockdown had a significant negative effect on diabetes dispanserization rates (estimate = −8 511.2, SE = 1 883.7, p < 0.001), yet did not affect the rates

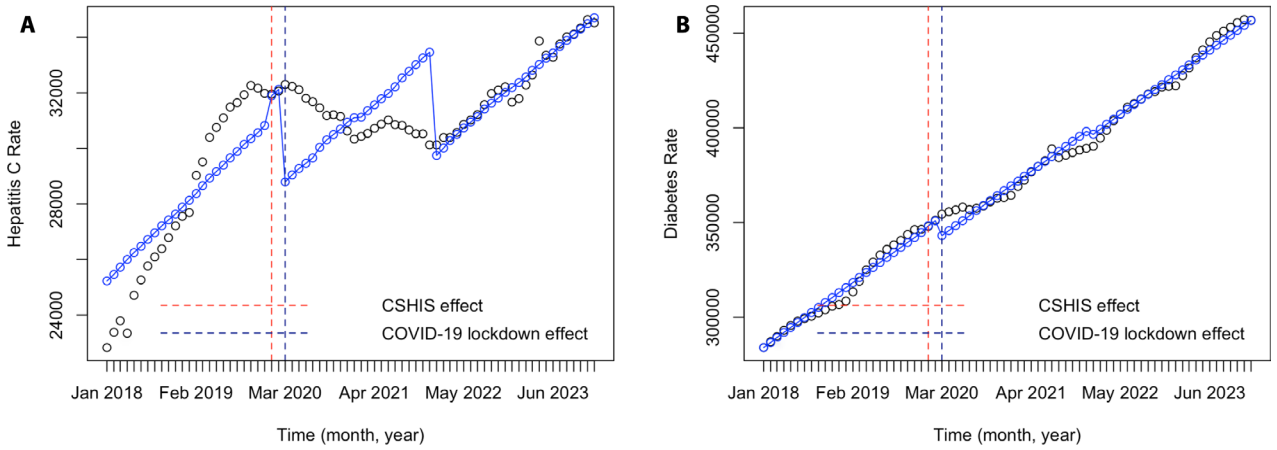

Figure 6. COVID-19 Lockdown Effect on Monthly A) Hepatitis C Dispanserization Rates Adjusted for the CSHIS Effect and the Country Population Size (2018-2023); B) Diabetes Dispanserization Rates Adjusted for the CSHIS Effect and the Country Population Size (2018-2023)

of hepatitis C dispanserization (estimate = −812, SE = 778, p = 0.3). It is important to note that both dispanserization rates show a significant upward trend over time. When the analysis was adjusted for the country's population size, the negative effect of the COVID-19 lockdown became significant for hepatitis C (estimate = −2 970, SE = 727, p < 0.01) and diabetes (estimate = −9 790, SE = 2 110, p < 0.001), while the increasing population size had a significant negative effect. After adjusting for the effect of CSHIS implementation, the lockdown effect remained significant for hepatitis C (estimate = −2 920.1, SE = 1 317.2, p = 0.03) and diabetes (estimate = −9 772, SE = 3 261.2, p < 0.01), while the CSHIS implementation effect was not significant in either case. When the COVID-19 lockdown effect was adjusted for the country's population size and CSHIS implementation, the lockdown effect remained significant for hepatitis C (estimate = −3,590, SE = 1,100, p < 0.01) and diabetes (estimate = −10,500, SE = 3,210, p < 0.01). Population growth had a significant negative effect on both dispanserization rates, while the CSHIS implementation effect remained insignificant in both cases. In addition, the obtained data shows that both hepatitis C and diabetes dispanserization rates are growing, and ITS results confirm the significant upward trend over time. From 2009 to 2020, the primary morbidity of viral hepatitis C declined significantly, with rates dropping from 0.83 to 0.28 per 100,000 population, marking a 4.4-fold reduction (13). One way to explain the decrease in primary morbidity could be the heavily underfunded healthcare system with high out-of-pocket costs, which hindered access to medical services and, consequently, led to a decrease in the number of people diagnosed with hepatitis C (11). In 2020, the highest proportion of hepatitis C carriers (14.7%) was found among patients undergoing drug treatment in hospitals (13). In 2021, significant risk factors of hepatitis C in three major regions of Kazakhstan were also identified as having a family member infected with viral hepatitis and a history of blood transfusion (14). These factors also highlight the negative consequences of the underfunded, low-quality healthcare system, where medical treatment remains a significant risk factor for hepatitis C infection.

The prevalence of both type 1 and type 2 diabetes in Kazakhstan increased by 1.7 times between 2014 and 2019, according to epidemiological data (15). The analysis of awareness shows that urban populations and women in particular have a significantly higher level of awareness, treatment and control of diabetes (16). A nationwide study investigating clinical characteristics and risk factors among COVID-19 patients with diabetes in Kazakhstan reported that diabetes as a comorbidity was significantly associated with increased in-hospital mortality (17). Additionally, research on type 2 diabetes in the country indicates that individuals over 45 years of age, women, and those with elevated

waist circumference are more likely to be newly diagnosed with type 2 diabetes mellitus (18). Conversely, being over 45, having a high waist circumference, and a family history of diabetes are linked to preexisting type 2 diabetes mellitus (18). The data from our analysis align with global projections that indicate a continuous rise in diabetes prevalence, further highlighting the urgency of improving diabetes management and healthcare delivery systems in Kazakhstan to mitigate the disease's growing burden. Approximately 529 million people worldwide had diabetes in 2021, and the global age standardized diabetes prevalence was 6.1% (19). By 2050, more than 1.31 billion people are expected to have diabetes, with age-standardized rates above 10% in 89 (43%) of 204 countries and territories (19). The results of the present analysis provide insight into the latent population of the country. Our findings are contradictory when compared to other studies in the same area. A recent analysis investigating the effect of the COVID-19 lockdown and CSHIS implementation on live birth rates in Kazakhstan found that CSHIS implementation had a significant positive impact on live birth rates, whereas the COVID-19 lockdown did not (20). There are several aspects of the healthcare system and medical services that are worth discussing. Socially significant and infectious diseases have always been covered under Kazakhstan's guaranteed volume of free medical care (21). In October 2020, the Government of the Republic of Kazakhstan issued a decree updating the list of services included in the guaranteed volume of free medical care outside of CSHIS coverage, which includes the diagnosis and treatment of socially significant and infectious diseases (22). Hepatitis C and diabetes fall into this category, which means that the introduction of CSHIS has not changed medical care for patients with hepatitis C and diabetes (22). As a result, we do not observe an effect of CSHIS implementation on the dispanserization rates of hepatitis C and diabetes, yet we do see a negative impact from the COVID-19 lockdown. The introduction of CSHIS altered the healthcare system's financing mechanism, improving access to and affordability of healthcare services, potentially boosting couples' reproductive confidence and reducing out-of-pocket expenses related to pregnancy monitoring and obstetric services (23,24). However, since hepatitis C and diabetes remained covered under the guaranteed volume of care, their dispanserization rates remained unaffected by the policy change. Limitations of the study: 1) This study might not consider various elements that could affect chronic disease dispanserization rates, such as economic conditions, environmental factors, cultural shifts, or other policy changes. 2) This analysis is limited to data through December 2023. Additional long-term data would be useful in confirming the ongoing impact of CSHIS on dispanserization rates. 3) It is assumed in the study that CSHIS implementation led to uniform improvements in healthcare access and quality for the entire population, which may not necessarily be true. 4) The present analysis does not account for the fact that CSHIS coverage is a variable that changes over time, with insurance coverage rates increasing from 82.6% in 2021 to 86.5% in 2023 (23).

Conclusion

The COVID-19 pandemic had a significant negative impact on dispanserization rates for both hepatitis C and diabetes in Kazakhstan. In contrast, our analysis shows that the implementation of CSHIS did not significantly affect the dispanserization rates of these chronic conditions. These findings emphasize the importance of implementing resilient policies that not only expand the coverage but also ensure the continuity of essential healthcare services from being disrupted during pandemics or other emergencies, so that patients continue to receive the medical care they need.

Ethic Approval: The Local Ethics Commission of Kazakhstan Medical University "KSPH" approved this study under Protocol #8, dated June 5, 2024.

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preparation, Writing – Review and Editing. BN: Supervision, Project Administration, Validation, Writing - Review and Editing. ZA: Resources, Writing – Original/draft preparation, Writing – Review and Editing. AS: Investigation, Writing – Review and Editing. AK: Formal Analysis, Resources, Writing – Original/draft preparation, Writing – Review and Editing.

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