# Central Asia SARS-CoV-2 Surveillance: A Longitudinal Trend Analysis

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# *Table of Contents*

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## *Abstract*

**Background:** SARS-CoV-2, the virus that caused the COVID-19 global pandemic, has severely impacted Central Asia, resulting in a high caseload and deaths that varied by country in Spring 2020. The varying severity of the pandemic is explained by differences in prevention efforts in the form of public health policy, adherence to those guidelines, as well as socio-cultural, climate, and population characteristics. The second wave of the COVID-19 currently is breaching the borders of Europe. Public health surveillance is necessary to inform policy and guide leaders; however, existing surveillance explains past transmissions obscuring shifts in the pandemic, increases in infection rates, and the persistence in the transmission of COVID-19.

**Objective:** The goal of this study is to provide enhanced surveillance metrics for COVID-19 transmission that account for shifts in the pandemic, week over week, speed, acceleration, jerk and persistence, to better understand country risk for explosive growth and those who are managing the pandemic successfully. Existing surveillance, coupled with our dynamic metrics of transmission, will inform health policy to control the COVID-19 pandemic until an effective vaccine is developed and provides novel metrics to measure the transmission of disease.

**Methods:** Using a longitudinal trend analysis study design, we extracted 60 days of COVID data from public health registries. We use an empirical difference equation to measure the daily number of cases in the Central Asia region as a function of the prior number of cases, the level of testing, and weekly shift variables based on a dynamic panel model that was estimated using the generalized method of moments (GMM) approach by implementing the Arellano-Bond estimator in R.

**Results:** COVID-19 transmission rates were tracked for the weeks of 9/30-10/06 and 10/07 to 10/13 in Central Asia. The region averaged 11,730 new cases per day for the week ending in 10/06 and 14,514 for the week ending in 10/13. Infection rates increased across the region from 4.74 per 100,000 in the population to 5.66. Infection rates varied by country. Russia and Turkey had the highest seven-day moving averages in the region, at 9,836 and 1,469 respectively for the week of 10/06 and 12,501 and 1,603 respectively for the week of 10/13. Russia has the fourth highest speed in the region and continues to have positive acceleration, driving the negative trend for the entire region as the largest country by population. Armenia is experiencing explosive growth of COVID-19, with an infection rate of 13.73 for the week of 10/06 quickly jumping to 25.19, the highest in the region, the following week. The pandemic speed in Armenia, consistent with the infection rate trajectory, increased from 15.4 to 21.7, with an acceleration increase from 0.4 to 1.6 meaning acceleration has increased fourfold. The region overall is experiencing increases in seven-day moving average of new cases, infection, rate and speed, with continued positive acceleration and no sign of a reversal in sight.

**Conclusions:** The rapidly evolving COVID-19 pandemic requires novel dynamic surveillance metrics in addition to static metrics to effectively analyze pandemic trajectory and control spread. Policymakers need to know the magnitude of transmission rates, how quickly they are accelerating, and how previous cases are impacting current caseload due to a lag effect. These metrics applied to Central Asia suggest that the region is trending negatively, primarily due to minimal restrictions in Russia. Russia already has the fourth highest number of cases in the world and current metrics suggest Russia will continue on that trajectory. Clinical Trial: NA

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**Keywords:** SARS-CoV-2 Surveillance; Second Wave; Wave Two; Global COVID Surveillance; Central Asia Public Health Surveillance; Central Asia COVID; Central Asia Surveillance Metrics; Dynamic Panel Data; Generalized Method of the Moments; Central Asia Econometrics; Central Asia SARS-CoV-2; Central Asia COVID Surveillance System; Central Asia COVID Transmission Speed; Central Asia COVID Transmission Acceleration; COVID Transmission Deceleration; COVID Transmission Jerk; COVID7-Day Lag; SARS-CoV-2; Arellano-Bond Estimator, Generalized Method of Moments GMM; Armenia; Azerbaijan; Cyprus; Faeroe Islands; Georgia; Gibraltar; Kazakhstan;

Kosovo; Kyrgyzstan; Macedonia; Russia; Tajikistan Turkey; Turkmenistan; Uzbekistan.

## Introduction

On December 29, 2019, four cases of "pneumonia of unknown etiology" were reported in Wuhan, Hubei Province, China [1]. What began as four isolated cases escalated into a global pandemic of SARS-CoV-2, the virus that causes COVID-19? To date, the caseload has reached 68,645,081 confirmed cases and 1,564,496 confirmed deaths globally [2]. Nations are reeling from the pandemic resulting in significant morbidity and mortality, food insecurity, and an economic recession that has not bottomed out. Global leaders are struggling with balancing disease control with salvaging their plummeting economies in the face of a global pandemic [3]. This study aims to examine where and when SARS-CoV-2 was transmitted in Central Asia within the context of a global pandemic by delving into the environmental, sociocultural, and public health characteristics of COVID-19. For purposes of this study, we use the World Bank's definition of Central Asia that includes Armenia, Azerbaijan, Cyprus, Faeroe Islands, Georgia, Gibraltar, Kazakhstan, Kosovo, Kyrgyzstan, Macedonia, Russia, Tajikistan, Turkey, Turkmenistan and Uzbekistan [4].

## History of Central Asia

Central Asia largely is made up of nation states that are former Soviet Union member countries. The USSR dissolved after controlling the region for 68 years in 1991 following a coup d'état during President Gorbachev's administration. The former Soviet Union left a lasting legacy on the former national republics [5]. The USSR went from centralized government and systems to independent states. Many essential institutions, such as national currency systems and military forces, were developed from the ground up. Many of these fledgling nations failed to achieve democracies which led to more chaos and conflict. The "colored revolutions" from 1999-2005, a series of mass protests and rioting, lead to overthrowing the semi-authoritarian regimes in Serbia, Georgia, Ukraine and Kyrgyzstan [6].

The public health of these new nations had many challenges such as endemic infectious diseases in Central Asia [7] such as tuberculosis, HIV, substance misuse [8, 9]. Alcohol poisoning is relatively common in the former USSR [10], contributing to low life expectancy in Russia [11, 12]. Central Asia has one of the highest prevalence rates of tobacco misuse [13]. Alcohol, tobacco and other substance misuse have both direct and indirect COVID-19 risk factors. Drinking alcohol, smoking, and misusing substances increases a person's risk of being infected with SARS-CoV-2 and having worse outcomes if infected [14-17]. Moreover, those persons who are self-isolating are at higher risk of substance misuse [18-20] Substance misuse also contributes to increases chronic disease [21-23]. During past epidemics, reduced access to medical care for individuals with serious illness, such as HIV or tuberculosis, resulted in more deaths from complications due to a dearth in health care[24, 25].


## Food and Water Security

Progress in food security [26] has stalled in recent years with growth in mal- and undernourished populations [27]. Malnourishment is a function of poverty [28, 29].

Food insecurity is linked to environmental conditions caused by overuse of the Aral Sea, which has been depleted by 90% since 1960 in order to irrigate large areas of land [30, 31]. Safe water is not available for 22 million people (31% of the population) throughout Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan. The majority of these individuals live in rural areas, where there are limited sewer connections and septic tanks [32]. People living near the highly polluted Aral Sea have higher levels of tuberculosis, anemia and cancer and may be at higher risk for debilitating SARS-CoV-2 infection [33].

Beyond access to food, obesity is becoming more pervasive [34] as Central Asian foods mirror the "Western diet" of high fat and low grains [26]. Traditional dishes have a high content of sodium, likely due to the "Silk Road" pattern in which countries along the former Silk Road, a trade route through Central Asia established in the second century B.C. [35, 36], use large quantities of salt for food preservation [37]. Obesity also contributes to chronic metabolic diseases and are associated with worse outcomes in those infected with SARS-CoV-2 [38].

## Current politics

Because Kazakhstan and China share a border, preventative measures in Kazakhstan were put in place as early as January 6, enforcing increased border sanitation and monitoring arrivals from China [39]. The first cases of COVID-19 in Kazakhstan, discovered in arrivals from Germany and Italy, were recorded on March 13. A state of emergency was announced on March 16; schools converted to remote learning, and quarantines were established in some areas as early as March 19 [39].

Many countries in the region have had disruptions in the labor market. Oil economies in Kazakhstan and Azerbaijan have been negatively impacted [40]. Tajikistan has experienced rising unemployment [29] and the poverty rate has risen across Central Asia [41-46].

State governments have attempted to minimize the impact of the virus; complaints about lack of adequate personal protective equipment in Russia were suppressed [47], medical authorities who gave public health advice in Turkey were criminally investigated [48] and the oppressive Turkmenistan government denied even a single case of SARS-CoV-2 [49].

In the electoral authoritarian regime of Azerbaijan, lockdown was put in place immediately following the first confirmed case of SARS-CoV-2 on February 28. The capital of Azerbaijan instated highly restrictive rules and shut down its border with the Islamic Republic of Iran, where cases were spreading quickly, the next day [50].

In Azerbaijan, violations of the quarantine mandate were punitive by fines, custodial restraint and prison time [51]. Severe rules were briefly in place; people over 65 were prohibited to leave their homes [50] and citizens were required to send a cellular text to a government phone number in order to request permission to leave their home for up to three hours. Political rivals were known to have their cellular service inactivated so that they could not request permission to leave their residence, and thus were confined to their home [51]. The pandemic has been exploited as a means to restrict individual human rights in other countries as well: government access to private cellphone data was allowed in Armenia [52] and protests were restricted in Russia [53]. In both Uzbekistan and Tajikistan [54], penalties were introduced for the spread of false information about the virus through the media.

While Azerbaijan initially slowed the virus' spread [55] and relaxed restrictions in May, the strict quarantine regime was reinstated in four major cities on June 21 after a surge in cases.

Shocking the international community, Russian President Vladimir Putin announced on August 11 that their country's health regulator was the first in the world to approve a SARS-CoV-2 vaccine for mass use [56]. This has been criticized as unsafe because the standard phase III clinical trials for new drugs was not completed at the time of his announcement [57]. While Russia's first approved vaccine, known as "Sputnik V," is still undergoing phase III trials, on October 14 President Putin announced the approval of a second SARS-CoV-2 vaccine [58]. Without adequate testing, we do not know the possible detrimental side effects of these vaccines, undermining the international community's attempt to produce a safe immunization [56].

Other than vaccine efforts, Russia has not implemented significant public health measures. During the first wave of infections in March, financial support was not given to small and medium businesses despite instructions for employees to stay home on paid leave [59]. However, in mid-April, it was announced that over 100 billion rubles would be allocated to support small and medium-sized businesses [54]. The number of active cases in Russia reached a peak at 245,580 on June 15 and then began to decline [60]. With the second wave of infections in October after loosening restrictions, Russia is seeing a spike in cases and has the fourth highest number of SARS-

CoV-2 cases worldwide, behind the United States, India and Brazil [61]. Russia reported a record number of 29,039 active cases on December 6 [60]. Despite record numbers of daily cases, with 26,097 new cases on December 8 for a total of 2,541,199 cases, protective measures continue to be rolled back. While gloves and masks are required in the Moscow metro, citizens must register their phone number before entering a bar or nightclub and museums are closed, international flights are gradually being reinstated and first through fifth graders are returning to school [62]. As early as July, the mayor of Moscow announced that wearing masks would no longer be required outdoors as new coronavirus cases dwindled in the capital [54].

Without an effective vaccine to prevent COVID-19, Central Asian leaders require an effective SARS-CoV-2 surveillance system allows their governments to make safe and informed decisions [63-70]. Public health departments[71-76], plus several universities[77] and media outlets[78, 79] are tracking the novel coronavirus using raw data including the number of new infections, testing, positivity, Rho, and deaths among other measures such as local hospital capacity.

To that end, the objective of our research is to use a longitudinal trend analysis study design in concert with *Dynamic Panel Modeling* and *Method of Moments* to correct for existing surveillance data limitations [80, 81]. Specifically, we will measure significant weekly shifts in the increase, decrease, or plateaued transmission of coronavirus. Our study will measure the underlying causal effect from last week that persists through this week, with a seven-day persistence rate to explain a clustering/de-clustering effect. The seven-day persistence represents an underlying disease transmission wave, where a large number of transmissions that resulted in a large number of infections today then 'echoes' forward into a large number of new transmissions and hence a large number of new cases seven days forward. An example of the seven-day lag would be large sporting events in the United Kingdom that drew large crowds over an extended period of time even after cases were confirmed in the country. Other potential “super spreader” events occurred in Turkmenistan when a mass cycling rally was held on April 7 to celebrate World Health Day [82]. In summary, we will measure negative and positive shifts in the transmission of SARS-CoV-2 or the acceleration/deceleration rates. Our surveillance metric will provide public health surveillance data to inform governments making decisions regarding disease control, mitigation strategies and reopening policies as they continue to manage this unprecedented situation.

An example of the seven day lag might have In summary, we will measure negative and positive shifts in the transmission of SARS-CoV-2, the speed, acceleration /deceleration and jerk rates along with 7-day persistence that do not suffer from sampling bias. For details see Oehmke et al [80, 83]

## Methods

This study relies on a longitudinal trend analysis on data collected from the Foundation for Innovative New Diagnostics (FIND) [84]. FIND compiles data from multiple sources across individual websites, statistical reports and press releases; data for the most recent eight weeks were accessed from the GitHub repository compiles data from multiple sources on the web; data for the most recent four weeks were accessed from the Github repository [85] . This resulted in a panel of 14 countries in Central Asia with 47-50 days in each panel (n=696). An empirical difference equation was specified in which the number of new positive cases in each country at each day is a function of the prior number of cases, the level of testing, and weekly shift variables that measure whether the contagion was growing faster/same/slower than the previous weeks. This resulted in a dynamic panel model that was estimated using the generalized method of moments (GMM) approach by implementing the Arellano-Bond estimator in R [86]. (GMM) approach by implementing the Arellano-Bond estimator in R. [80, 81]

Arellano-Bond estimation of difference equations has several statistical advantages: 1) it allows for statistical examination of the model's predictive ability and the validity of the model specification; 2) it corrects for autocorrelation and heteroscedasticity; 3) it has good properties for data with a small number of time periods and large number of states; 4) it corrects for omitted variables issues and provides a statistical test of correction validity. With these advantages, the method is applicable to ascertaining and statistically validating changes in the evolution of the pandemic within a period of a week or less, such as changes in the reproduction rate. See Oehmke et al. for detailed discussion of the methods [80, 83]. Finally, we calculate these indicators to inform public health leaders where to take corrective action at a local level. China enjoyed great success at controlling the pandemic by closing down smaller geographical regions and preserving the larger economy and other adverse outcomes from a national quarantine.

## Results

### Country Regression Results

We have analyzed the 12 countries that fall into the Central Asia region as defined by the World Bank. The results of the associated regression supporting the weekly surveillance metrics are captured in Table 1.

The Wald statistic for regression is significant ($X^2$ (7) =14,217, P<.001) as seen in Table 1. The Sargan statistic for validity is insignificant ($X^2$ (550) =9, P=1), and fails to reject the validity of over identifying restrictions.

**Table 1. Arellano-Bond Dynamic Panel Data Modeling of the Number of Daily Infections Reported by Country, September 30th to October 13th, 2020.**

| Central Asia | |
|---|---|
| **Variable** | **Coefficient (*P*-value)** |
| L1Pos | 1.075 (<.001) |
| L7Pos | -.051 (.887) |
| Cumulative Tests | .000016 (.549) |
| Shift parameter week of October 6th | -.157 (.525) |
| Shift parameter week of October 13th | -.417 (.115) |
| Weekend | -.009 (.989) |
| | |
| Wald statistic for regression | $X^2$(7)=14,217 |
| | *P*<.001 |
| Sargan statistic for validity | $X^2$ (550)=9 |
| | *P*=1 |

As seen in Table 1, the one-day lag coefficient (L1Pos) is positive and significant (1.075, P<.001), suggesting a clustering effect where cases on a given day impact the number of cases on adjoining days. The seven-day lag coefficient and weekend effect, or impact of the limited testing over the weekend on case counts, are both insignificant. Shift parameters for the weeks of October 6th and 13th are also insignificant, suggesting no major changes in rate of disease transmission in the region between these two weeks in general. The coefficient for cumulative tests is insignificant.

## Interpretation: Central Asian regression results

The seven-day lag and shift parameters suggest that there have been no recent changes in disease transmission rates. Additionally, there is no weekend effect or cumulative test effect.

## Surveillance Results

Static and dynamic surveillance metrics for the weeks of 10/06 and 10/13 are reflected in Tables 2-7. Tables 2 and 3 capture static metrics including number of new COVID cases, cumulative COVID cases, 7-day moving average of new cases, rate of infection, new deaths, cumulative deaths, 7-day moving average of number of deaths, and death rates. Novel dynamic metrics are reflected in Tables 4 and 5. These metrics include 1) Speed, or the weekly average of new daily cases per 100K, 2) Acceleration, or the day to day change in speed, 3) Jerk, or the week over week change in acceleration, 4) 7-day persistence effect or the number of new cases per 100K reported today that are associated with new cases reported seven days ago. Novel metrics allow for analysis of impact of previous cases on cases today and identification of potential changes of pandemic trajectory in the future.

Table 2 reflects static surveillance metrics for the week of 09/30-10/06 and Table 3 reflects those metrics for the week of 10/07-10/13. The region averaged 11,730 new cases per day for the week ending in 10/06 and 14,514 for the week ending in 10/13. Infection rate increased across the region from 4.74 per 100,000 in the population to 5.66. This increase in infection rate was accompanied by a slight increase in death rate from 0.09 per 100,000 in the population to 0.11. Up to

10/13, the region had reported 2,040,812 cumulative COVID-19 cases.

**Table 2. Static Surveillance Metrics for the Week of 09/30-10/06**

| Country | New COVID Cases | Cumulative COVID Cases | 7 Day Moving Average New Cases | Rate of Infection | New Deaths | Cumulative Deaths | 7 Day Moving Average of Death Rate | Rate of Deaths |
|---|---|---|---|---|---|---|---|---|
| Armenia | 406 | 53083 | 454.57 | 13.73 | 6 | 990 | 4.57 | 0.20 |
| Azerbaijan | 143 | 40931 | 116.00 | 1.43 | 2 | 600 | 1.43 | 0.02 |
| Cyprus | 29 | 1876 | 19.00 | 2.42 | 1 | 23 | 0.14 | 0.08 |
| Georgia | 549 | 9245 | 482.71 | 14.76 | 4 | 58 | 3.14 | 0.11 |
| Kazakhstan | 66 | 108362 | 64.86 | 0.36 | 21 | 1746 | 3.00 | 0.11 |
| Kosovo | 34 | 15889 | 45.00 | 1.89 | 2 | 635 | 1.43 | 0.11 |
| Kyrgyzstan | 164 | 47799 | 182.43 | 2.54 | 0 | 1066 | 0.29 | 0 |
| North Macedonia | 223 | 19096 | 187.14 | 10.70 | 8 | 768 | 4.43 | 0.38 |
| Russia | 11481 | 1231277 | 9835.57 | 7.95 | 184 | 21559 | 157.57 | 0.13 |
| Tajikistan | 40 | 10014 | 41.14 | 0.43 | 0 | 78 | 0.43 | 0 |
| Turkey | 1511 | 327557 | 1469.29 | 1.81 | 55 | 8553 | 60.43 | 0.07 |
| Uzbekistan | 397 | 59343 | 427.00 | 1.18 | 4 | 489 | 3.29 | 0.01 |

**Table 3. Static Surveillance Metrics for the Week of 10/07-10/13**

| Country | New COVID Cases | Cumulative COVID Cases | 7 Day Moving Average New Cases | Rate of Infection | New Deaths | Cumulative Deaths | 7 Day Moving Average of Death Rate | Rate of Deaths |
|---|---|---|---|---|---|---|---|---|
| Armenia | 745 | 57566 | 640.43 | 25.19 | 6 | 1032 | 6.00 | 0.20 |
| Azerbaijan | 277 | 42381 | 207.14 | 2.76 | 3 | 612 | 1.71 | 0.03 |
| Cyprus | 83 | 2130 | 36.29 | 6.92 | 0 | 25 | 0.29 | 0.00 |
| Georgia | 569 | 12841 | 513.71 | 15.29 | 9 | 102 | 6.29 | 0.24 |
| Kazakhstan | 83 | 108984 | 88.86 | 0.45 | 22 | 1768 | 3.14 | 0.12 |
| Kosovo | 98 | 16345 | 65.14 | 5.46 | 1 | 649 | 2.00 | 0.06 |
| Kyrgyzstan | 343 | 49871 | 296.00 | 5.31 | 2 | 1092 | 3.71 | 0.03 |
| North Macedonia | 80 | 21193 | 299.57 | 3.84 | 3 | 800 | 4.57 | 0.14 |
| Russia | 13690 | 1318783 | 12500.86 | 9.48 | 240 | 22834 | 182.14 | 0.17 |
| Tajikistan | 37 | 10297 | 40.43 | 0.40 | 0 | 79 | 0.14 | 0.00 |
| Turkey | 1632 | 338779 | 1603.14 | 1.96 | 62 | 8957 | 57.71 | 0.07 |
| Uzbekistan | 323 | 61642 | 328.43 | 0.96 | 2 | 511 | 3.14 | 0.01 |

Russia and Turkey had the highest seven-day moving averages in the region, at 9,836 and

1,469 respectively for the week of 10/06 and 12,501 and 1,603 respectively for the week of 10/13 (Table 2 and 3). In terms of infection rate, accounting for population, Russia was at 7.95 and Turkey was at 1.81 per 100,000 for the week of 10/06. The countries that had the highest infection rates in the region included Georgia at 14.76 and Armenia at 13.73. For the following week, the infection rate in Armenia jumped to the highest in the region at 25.19 while Georgia had a very slight increase to 15.29. Kazakhstan had the lowest infection rate in the region at 0.36 for the week of 10/06.

Russia and Turkey also had the highest seven-day moving average of deaths in the region, with Russia at 157.57 for the week of 10/06 and Turkey at 60.43. Together, they accounted for ~90% of the deaths reported in the region. Up to 10/13 the region had reported 38,461 cumulative deaths. For the week of 10/06, North Macedonia and Armenia had the highest death rates per 100,000 in the region, at 0.38 and 0.20 respectively. Armenia maintained a death rate of 0.20 the following week. Georgia had the highest death rate the week of 10/13 at 0.24, up from 0.11 the previous week.

**Table 4. Novel Surveillance Metrics for the Week of 09/30-10/06**

| Country | SPEED: Daily positives per 100K (weekly average of new daily cases per 100K) | ACCELERATION: day-to-day change in the number of positives per day, weekly average, per 100K | JERK: week over week change in ACCELERATION, per 100K | 7-DAY PERSISTENCE EFFECT on SPEED (# new cases per day per 100K) |
|---|---|---|---|---|
| Armenia | 15.4 | 0.4 | 0.3 | -0.6 |
| Azerbaijan | 1.2 | 0.1 | 0 | -0.1 |
| Cyprus | 1.6 | 0 | -0.1 | -0.1 |
| Georgia | 13.0 | 0.9 | -0.2 | -0.4 |
| Kazakhstan | 0.4 | 0 | 0 | 0 |
| Kosovo | 2.5 | -0.2 | -0.1 | -0.1 |
| Kyrgyzstan | 2.8 | 0 | -0.2 | -0.1 |
| North Macedonia | 9.0 | 0.8 | 0.5 | -0.3 |
| Russia | 6.8 | 0.3 | 0.1 | -0.3 |
| Tajikistan | 0.4 | 0 | 0.0 | 0 |
| Turkey | 1.8 | 0 | 0.0 | -0.1 |
| Uzbekistan | 1.3 | -0.1 | 0.0 | -0.1 |

**Table 5. Novel Surveillance Metrics for the Week of 10/07-10/13**

| Country | SPEED: Daily positives per 100K | ACCELERATION: day-to-day change | JERK: week over week change in | 7-DAY PERSISTENCE |
|---|---|---|---|---|

| | (weekly average of new daily cases per 100K) | in the number of positives per day, weekly average, per 100K | ACCELERATION, per 100K | EFFECT on SPEED (# new cases per day per 100K) |
|---|---|---|---|---|
| Armenia | 21.7 | 1.6 | 0.7 | -0.8 |
| Azerbaijan | 2.1 | 0.2 | 0.2 | -0.1 |
| Cyprus | 3.0 | 0.6 | 0.4 | -0.1 |
| Georgia | 13.8 | 0.1 | 0.5 | -0.7 |
| Kazakhstan | 0.5 | 0 | 0 | 0 |
| Kosovo | 3.6 | 0.5 | 0.3 | -0.1 |
| Kyrgyzstan | 4.6 | 0.4 | 0.2 | -0.1 |
| North Macedonia | 14.4 | -1.0 | -1.6 | -0.5 |
| Russia | 5.2 | 0.1 | 0.0 | -0.2 |
| Tajikistan | 8.7 | 0.2 | 0.0 | -0.4 |
| Turkey | 0.4 | 0 | 0.0 | 0 |
| Uzbekistan | 1.9 | 0 | 0.0 | -0.1 |

Largely consistent with infection rates, Armenia, Georgia, and North Macedonia had the highest speed or average of new daily cases per 100,000 in the population. During the week of 10/06 Armenia had a speed of 15.4, increasing to 21.7 the following week. Georgia had a speed of 13.0 increasing slightly to 13.8. North Macedonia had a speed of 9.0, increasing to 14.4. The region overall had an increase in speed from 4.2 to 5.2.

Speed is best utilized in conjunction with acceleration and jerk, which can provide further insight into potential pandemic trajectory changes. Four countries in the region had significant positive acceleration for the week of 10/6: Georgia at 0.9, North Macedonia at 0.8, Armenia at 0.4 and Russia at 0.3. North Macedonia, Armenia, and Russia also had a positive jerk. During the following week, in addition to the highest speed, Armenia also had the highest acceleration and jerk in the region.

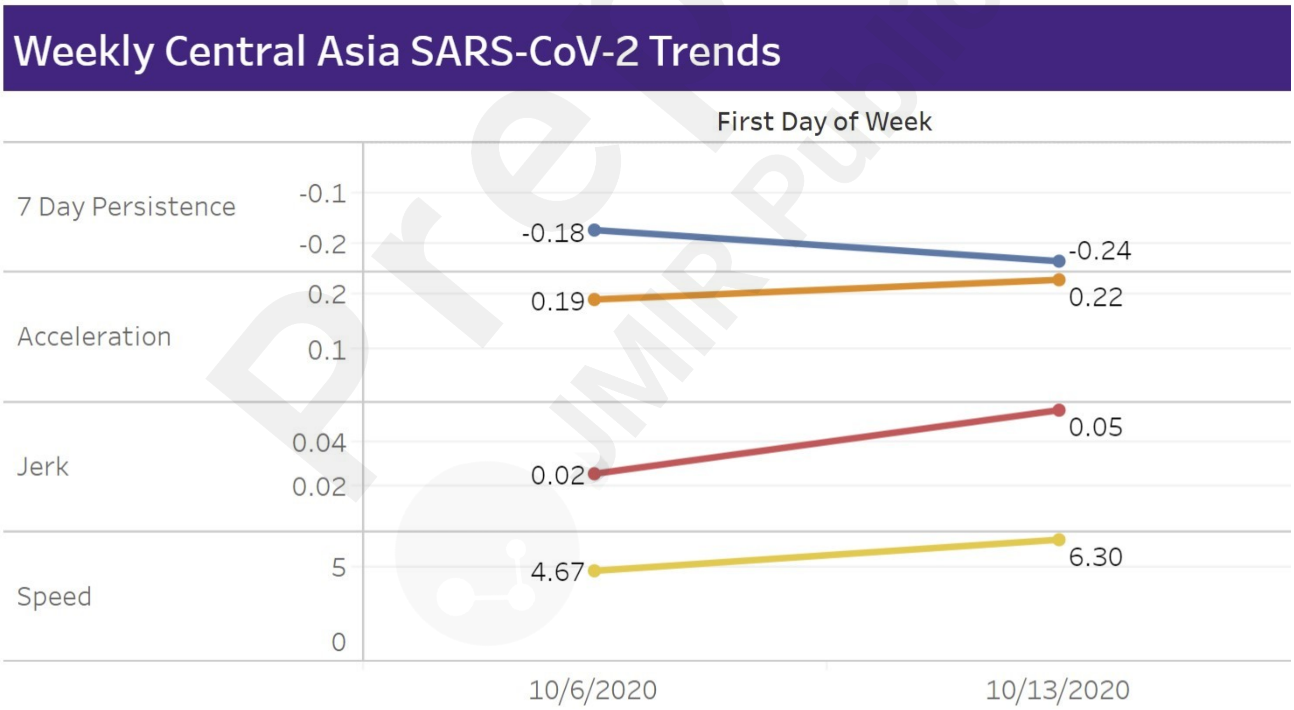
**Table 6. 1-Day Persistence Comparison**

| 1-Day Persistence 9/30/2020 | | 1-Day Persistence 10/06/2020 | |
|---|---|---|---|
| Armenia | 16.1 | Armenia | 21.5 |
| Georgia | 13.0 | North Macedonia | 16.5 |
| North Macedonia | 8.8 | Georgia | 14.8 |
| Russia | 7.0 | Russia | 9.1 |

One-day persistence is an indicator of a clustering effect where an event on a particular day causes an increase in the number of cases on adjoining days. As shown in Table 6, one-day persistence was highest in Armenia at 16.1 and increased to 21.5 the following week. North Macedonia saw a large increase from 8.8 to 16.5, with Georgia and Russia seeing smaller increases from 13.0 to 14.8 and 7.0 to 9.1 respectively.

**Table 7. Most Populous Countries in Central Asia**

| Country | Population as of 2020 |
|---|---:|
| Russia | 145,953,632 |
| Turkey | 84,621,255 |
| Uzbekistan | 33,469,203 |
| Kazakhstan | 18,776,707 |




https://public.tableau.com/profile/lori.post#!/vizhome/GlobalSARS-CoV-2SurveillancePolicyPersistenceandTransmission-CentralAsia/Story

# Discussion

## Principal results

COVID-19 poses a significant threat to the Central Asian region, largely composed of former Soviet republics. These countries continue to suffer from food insecurity, high levels of poverty, and variation in healthcare quality and access as the region continues on its journey transitioning from a centralized Soviet medical system. The population also suffers from multiple endemic infections such as HIV/AIDS and tuberculosis. Russia and Turkey comprise the bulk of the population in Central Asia, suffer from a growing burden of chronic disease and some of the highest obesity rates in Europe. These factors combined make the region vulnerable to negative outcomes from the COVID-19 pandemic. To date, the region has seen variation in policy intervention to control the spread of COVID and mitigate outbreaks. Some countries like Kazakhstan and Azerbaijan have imposed strict and early lockdowns while others such as Russia have imposed more limited interventions.

Metrics tracking the progression of COVID in the region to date have largely been static, including measures such as new cases, cumulative cases, deaths, and 7-day moving averages. These metrics provide a view of the current state of the pandemic but are unable to provide any insight into change in speed of the pandemic over time or potential shifts in trajectory, evolving from controlled spread to rapid growth or vice versa. These metrics also provide limited utility in comparing countries to each other and analyzing countries with smaller populations. Novel metrics, such as speed, acceleration, and jerk, help contextualize static metrics and provide a view of trajectory over time, allowing for potential anticipation of how the pandemic might evolve in the future.

Considering the static and dynamic metrics, it is apparent that the Central Asian region is trending negatively. The region has seen an increase in seven-day moving average of new cases, infection rate, and speed for the week of 10/13 compared to the week of 10/6, with continued positive acceleration. This trend is largely driven by Russia and Turkey, which together encompass over 70% of the region’s population and have the highest seven-day moving averages in the region. Russia has the fourth highest speed in the region and continues to have positive acceleration.

Kazakhstan, the fourth most populous country in the region, had the lowest infection rate for the week of 10/06. This is likely due to a continued emphasis on policy interventions to curb the spread of COVID-19. Kazakhstan took some of the earliest precautions to prevent infections and continues to strictly enforce pandemic mitigation measures, including halting the easing of restrictions due to the global spike in COVID-19 cases in recent weeks.

Turkey, while contributing a significant portion of the total cases in the region due to its population size, has maintained a relatively low infection rate of 1.81 and 1.96 for the weeks of 10/06 and 10/13 respectively. Turkey has taken significant precautions to mitigate the spread of the virus and continues to enforce rigorous mask wearing and social distancing guidelines, along with local quarantines when necessary.

Armenia is experiencing uncontrolled spread of COVID-19, with an infection rate of 13.73 for the week of 10/06 quickly jumping to 25.19, the highest in the region, the following week. The pandemic speed, consistent with the infection rate trajectory, increased from 15.4 to 21.7, with an acceleration increase from 0.4 to 1.6. This change is likely due to the recent lifting of the Coronavirus state of emergency, allowing in-person schooling and international flights to resume among other things.

After Armenia, Georgia and Russia have the highest infection rates in the region for the week of 10/13. Russia continues to resist implementing COVID interventions to curb the spread of the virus, with no mask mandates, capacity caps, or nightlife restrictions. Besides the significant focus on developing an effective vaccine, there is limited intervention to manage the spread of COVID in Russia. This policy stance is impacting the trajectory of the region, which is trending negatively with no sign of a reversal in sight.

## Conclusion

The rapid evolving, novel outbreaks, and frequently fluctuating trajectory of COVID-19 cannot be adequately assessed using static public health measures alone. Static measures, including number of new COVID cases, cumulative COVID cases, 7-day moving average of new cases, rate of infection, new deaths, cumulative deaths, 7-day moving average of number of deaths, and death rates, provide a current state view of the pandemic. However, they do not provide any insight into how the trajectory of the pandemic may change over time.

Generally, the approach to modeling COVID-19 is to assume there is an underlying contagion model [87] and then and then to attempt to measure those model parameters [88] which involves contact tracing to determine the spread of the disease [89-92]. With an incubation period of up to 14 days [93], it takes months to model. Early estimates of COVID-19 were developed by Lipsitch [94] who used contact tracing in Wuhan and Italy; however, the statistical properties were weak [95-100]. Zhao [96] estimated the serial interval distribution and $R_0$ based on only six pairs of cases which is insufficient to understand the transmission of COVID-19 [101]. This results in relaxing the assumptions in these models. For example, disaggregating the population by geography and modeling within-geography and across-geography personal interactions [102]. Martcheva [103] developed a dynamic model from several contagion models and their possible dynamics [104, 105]. They are limited for the statistical inference of parameter values from actual data [106].

Novel surveillance metrics allow for a more nuanced analysis of the COVID-19 pandemic and together with static metrics, can enable policymakers to make informed decisions to control the spread of the pandemic and prevent further outbreaks. Novel dynamic metrics include speed, acceleration, jerk, and 7-day persistence and enable potential insight into how the pandemic might evolve in the future.

The analysis of Central Asia using static and novel surveillance metrics suggests that the region is precariously positioned and trending negatively. Russia, the largest country by population, continues to have high infection rates and one of the highest speeds. With no sign of increasing restrictions, it is unlikely that this trend will reverse and outbreaks in the region will be controlled.

## Limitations

Our data are limited by reporting methods across individual countries. Some countries such as Turkmenistan refuse to acknowledge COVID-19 cases. Variation in testing and infrastructure may impact the number of cases other countries report. The data are reported at a national level which does not allow for any subnational analysis.

## Comparison to prior work

This study is part of a broader research program at Northwestern Feinberg School of Medicine, The Global SARS-CoV-2 Surveillance Project: Policy, Persistence, & Transmission. Novel surveillance metrics including speed, acceleration, jerk, and 7-day persistence have been developed by this research program and are being applied to all global regions.

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## Conflicts of Interest

The authors have no conflicts of interest.

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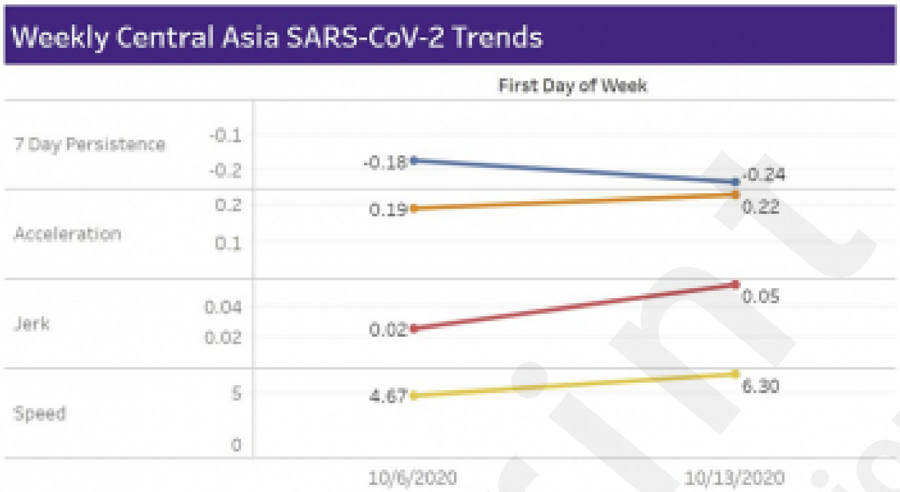
# Supplementary Files

# Figures

Central Asia timeline.

Weekly Central Asia SARS-CoV2 trends.



# Multimedia Appendixes

Weekly Cental Asia statistics by country.
URL: https://asset.jmir.pub/assets/3a66683d3ef8bd9d4e22f458e57ffc60.png

Weekly Central Asia statistics.
URL: https://asset.jmir.pub/assets/33f3c8710d67dab20e249b706325a6d2.png

Weekly Central Asia 7 day persistence map.
URL: https://asset.jmir.pub/assets/0d3c9ebab52374847f9847519dd3daf1.png

Weekly Central Asia jerk map.
URL: https://asset.jmir.pub/assets/857cb26c3dd43a5c5b91552598dfa329.png

Weekly Central Asia acceleration jerk map.
URL: https://asset.jmir.pub/assets/447b291b3da139179f1d1b281a8fc0ff.png

# TOC/Feature image for homepages

On the bus in Turkey.