

FORMATION OF HERD IMMUNITY TO SARS-CoV-2 IN THE REGIONS OF UZBEKISTAN

Rakhimov R.A., Ibadullaeva N.S., Khikmatullaeva A.S., Abdukadirova M.A., Sadirova Sh.S., Lokteva L.M., Rakhimov R.R., Bayjanov A.K., Samatova I.R.

Research Institute of Virology, Uzbekistan

Summary. 6 months after the start of the COVID-19 epidemic in Uzbekistan, a comparative analysis of the reported incidence of COVID-19 and the level of herd immunity to SARS-CoV-2 was carried out. The registration of patients with COVID-19 in the country was carried out on the basis of the positive results of the examination for the presence of SARS-CoV-2 RNA, using the PCR method. To study herd immunity, the WanTai SARS-CoV-2 Ab Rapid test (China) was used to detect total antibodies (IgM and IgG) in blood. In the period from August 27, 2020 to September 11, 2020, in all 14 administrative-territorial regions of Uzbekistan, blood samples of 86879 people who sought medical help at an outpatient clinic at their place of residence were tested for the presence of total antibodies to SARS-CoV-2. According to official figures, 0.14% of the population were infected with COVID-19. The proportion of the population with the presence of specific protective antibodies to the SARS-CoV-2 virus was 23.1%. This proves that the actual incidence of COVID-19, on the national average, was at least 165 times higher than officially reported. An uneven territorial distribution of the level of herd immunity was revealed. All regions were conditionally divided into 3 zones: 1) regions with a high level of herd immunity > 20% (8 regions), 2) regions with an average level of herd immunity < 20% and > 10% (3 regions), 3) regions with a low the level of herd immunity < 10% (3 regions). The degree of population affected in different regions of the county did not depend on the population density in the region, its age and gender composition. It was shown that the factors that influenced the intensity of the epidemic process and the formation of the level of herd immunity were the degree of external and internal migration.

Keywords: SARS-COV-2, COVID-19, IgM, IgG, herd immunity.

Introduction. At the end of 2019, an outbreak of SARS caused by a new coronavirus occurred in the People's Republic of China (PRC), with the epicenter in the city of Wuhan (Hubei province) [1]. The International Committee on Taxonomy of Viruses (ICTV, <https://council.science/current/blog/whats--point-of-virus-taxonomy/>), named the causative agent SARS-CoV-2. The disease caused by the new coronavirus has been designated by the World Health Organization (WHO) as COVID-19 [2]. In February 2020, WHO identified the global COVID-19 epidemic as a pandemic. Uzbekistan, like many countries of the world, has been involved in a pandemic since March 2020. The registration of COVID-19 cases in Uzbekistan is carried out on the basis of positive laboratory test results for the SARS-CoV-2 genome, using the polymerase chain reaction (PCR) method. However, for a number of objective reasons, it is practically impossible to examine all patients with COVID-19. Such patients remain undetected and not accounted for in official statistics. However, they are active participants in the epidemic process and the formation of herd immunity to SARS-CoV-2 [3, 4, 5].

The level of herd immunity is one of the important regulators of the intensity of the epidemic process. Therefore, the determination of herd immunity to the SARS-CoV-2 virus is a prerequisite for assessing the epidemic situation and predicting its further development [6, 7]. The aim of the study was to study the level of herd immunity to SARS-CoV-2 in the Republic of Uzbekistan in the context of administrative territories.

Materials and methods.

The registration of patients with COVID-19 in Uzbekistan is carried out on the basis of daily data of positive results of examination of patients for the presence of SARS-CoV-2 RNA, using the PCR method, information about which is transmitted daily to the platform of the World Health Organization for epidemiological surveillance of COVID-19 (<https://covid19.who.int/region/euro/country/uz>). To study herd immunity, the WanTai SARS-CoV-2 Ab Rapid test (China) was used to detect total antibodies (IgM and IgG) to SARS-CoV-2 in blood. Uzbekistan is divided into 14 administrative territories (12 regions, the autonomous Republic of Karakalpakstan and the capital of Uzbekistan - the city of Tashkent). In the period from August 27, 2020 to September 11, 2020, in all 14 administrative-territorial regions of Uzbekistan, blood serum samples of 86879 people who sought medical help at an outpatient clinic at their place of residence were tested for the presence of total antibodies to SARS-CoV-2. To calculate the

intensive incidence rates, official statistical data on the number of the population was used in the context of the regions of the Republic of Uzbekistan for 2020.

Results.

The first laboratory-confirmed case of COVID-19 in Uzbekistan was detected in the city of Tashkent on March 15, 2020. According to official statistics based on the results of laboratory examination of patients for the presence of the SARS-CoV-2 virus genome, from March 15 to September 11, 2020 in Uzbekistan, 46,272 people or 0.14% of the total population of the country have been infected with COVID-19 (Table 1.).

Table 1.
The incidence rate of COVID-19 in Uzbekistan by 09/11/2020

No	Administrative-territorial regions	Population (1000 people)	Number of COVID-19 patients identified	Intensive indicator (per 100 000 population)
1	Andijan region	3139,8	1287	41,0±1,1
2	Bukhara region	1929,1	1075	55,7±1,7
3	Jizzakh region	1388,5	163	11,7±0,9
4	Kashkadarya region	3293,6	1019	30,9±1,0
5	Navoi region	1000,6	514	51,4±2,3
6	Namangan region	2821,9	1020	36,1±1,1
7	Samarkand region	3892,5	1853	47,6±1,1
8	Surkhandarya region	2640,6	646	24,5±1,0
9	Syrdarya region	849,7	763	89,8±3,2
10	Tashkent region	2951,5	8450	286,3±3,1
11	Fergana region	3766,0	354	9,4±0,5
12	Khorezm region	1872,2	503	26,9±1,2
13	Republic of Karakalpakstan	1903,9	468	24,6±1,1
14	Tashkent city (capital)	2 586,9	28157	1088,5±6,5
	The Republic of Uzbekistan	34036,8	46272	135,9±0,6

Since the registration of patients was carried out only on the basis of laboratory confirmation of the detection of the SARS-CoV-2 genome, this tactic could not ensure the identification of all patients with COVID-19 [8].

The highest incidence of COVID-19 was registered in Tashkent city and Tashkent region, located around Tashkent city (8.0 and 2.1 times higher than the national average). This, on the one hand, is explained by more intensive external and internal migration, as well as the location of most of the quarantine points for external migrants in these regions. On the other hand, laboratory diagnostics of COVID-19 was more accessible to the population of these regions than in population of other regions. Simultaneously with the beginning of the epidemic process of COVID-19, the process of formation of herd immunity to the SARS-CoV-2 virus began. The level of herd immunity to SARS-CoV-2 is currently determined (before the start of mass vaccination of the herd) by the number of people who actually recovered and developed a sufficient titer of specific protective antibodies. Herd immunity is an important regulator of the intensity of the epidemic process in the country and can be used to predict the epidemic situation. The higher the level of herd immunity, the less likely it is to meet the source of infection and the susceptible person, hence the less intense the spread of infection. 6 months after the start of the epidemic, to determine the level of herd immunity, the herd was screened for the presence of specific antibodies to the SARS-CoV-2 virus in all 14 regions of the country (Table 2).

Table 2.**Results of testing of population for antibodies to SARS-CoV-2 virus**

No	Administrative-territorial regions	Examined (person)	Number of antibody positive tests	%
In Uzbekistan		86879	19869	23,1±0,1
1. Zone with a high level of herd immunity				
1	Bukhara region	5000	1890	38,1±0,7
2	Khorezm region	5000	1801	36,0±0,7
3	Navoi region	6000	2039	34,1±0,6
4	Surkhandarya region	4000	1299	32,0±0,7
5	Republic of Karakalpakstan	6950	2243	32,0±0,6
6	Samarkand region	8000	2499	31,0±0,5
7	Tashkent region	8000	1901	24,2±0,5
8	Tashkent city	14929	3011	20,7±0,3
Average indicators		57879	16683	28,8±0,2
2. Zone with an average level of herd immunity				

1	Kashkadarya region	6000	993	17,0±0,5
2	Syrdarya region	4000	653	16,1±0,6
3	Jizzakh region	4000	593	15,0±0,6
Average indicators		14000	2239	16,0±0,3
3. Zone with low level of herd immunity				
1	Namangan region	6000	463	8,0±0,1
2	Andijan region	5000	292	6,0±0,3
3	Fergana region	4000	192	5,0±0,4
Average indicators		15000	947	6,3±0,2

The survey results showed that the spread of COVID-19 was much more intense than official data. For 6 months (from the beginning of the epidemic to the moment of the study), according to official data, 0.14% of the population had been infected with COVID-19. The proportion of the population with the presence of specific protective antibodies to the SARS-CoV-2 virus reached 23.1% during this period. This proves that the actual incidence of COVID-19, on average in the country, was at least 165 times higher than the officially registered [8, 9, 10, 11, 12]. Formed by the time of the screening, the level of herd immunity to the SARS-CoV-2 virus contributed to a decrease in the intensity of the epidemic process COVID-19 [13, 14].

Analysis of the results of determining herd immunity to SARS-CoV-2 showed its uneven territorial distribution. All regions were conditionally divided into 3 zones: 1) regions with a high level of herd immunity >20% (8 regions), 2) regions with an average level of herd immunity <20% and >10% (3 regions), 3) regions with a low the level of herd immunity <10% (3 regions).

The factors that could affect the intensity of the epidemic process and the formation of the level of herd immunity in each zone were determined.

No reliable relationship was found between different levels of herd immunity either with population density, or with sex and age composition [13].

According to the WHO, the COVID-19 epidemic began in China at the end of 2019, and COVID-19 cases began to be detected in many countries at the beginning of 2020. Uzbekistan introduced quarantine restrictions on external migration by auto, air and rail from March 16, 2020. However, according to the State Committee of the Republic of Uzbekistan for Tourism Development, in January-March 2020, before the introduction of quarantine, 1 million 216 thousand people managed to visit the republic (<https://uzbektourism.uz/ru>). Tourists from

non-CIS countries mainly arrived by air. In addition, after the introduction of quarantine restrictions, more than 467 thousand citizens and labor migrants returned to the country. The National Airline "Uzbekistan Airways" includes 11 airports (<http://www.uzbekistan-airlines.de>). Of these, all 6 airports with the "international" status and receiving passenger flights from far abroad are located in zone 1. There are dozens of popular tourists, archaeological and other objects in 7 regions of zone 1. And in the 8th region (Navoi region) there is a free economic region, in connection with which the Navoi airport provides regular flights with twelve countries of the Euro-Asian continent. So, in these regions the highest level of occupancy of accommodation facilities for foreign tourists was noted (74.3% - 96.6%). The presence of intensive external and internal migration explains the fact that the level of herd immunity in the regions of zone No.1 turned out to be significantly ($p < 0.001$) 18.0 and 4.6 times higher than, respectively, in the regions of zones 2 and 3.

There are significantly fewer tourist, archaeological and other objects in 3 regions of zone No. 2. But practically all 3 regions border on the regions of zone 1 and there is an extensive network of transit roads on their territory. This contributed to the rather intensive internal migration of the herd of these regions, and with this the moderate spread of COVID-19 and the formation of the average level of herd immunity.

All 3 regions of zone 3 are located isolated from other regions, in a valley (Fergana Valley), surrounded by closed mountain ranges. Only in the west there is a narrow passage through the mountains, leading to the main part of the country, through which there is a road and a railway track. This arrangement made it possible, during the quarantine measures, to effectively ensure the limitation of herd migration. The regions of zone 3 have the highest population density (378.0 - 744.7 people / km²), but the level of herd immunity turned out to be the lowest. This indicates a low intensity of the COVID-19 epidemic process in this area.

Conclusions

The study showed that the actual number of people infected with COVID-19, on the national average, was at least 165 times higher than the officially registered incidence. By mid-September 2020, 6 months after the start of the epidemic in Uzbekistan, the level of herd immunity to the SARS-CoV-2 virus reached 23.1%. The spread of COVID-19 in different regions of the country was influenced by the intensity of external and internal migration before the pandemic and at the beginning of the pandemic. The highest spread of COVID-19 was observed in

regions where there were conditions for the migration of tourists from far abroad. The lowest prevalence of COVID-19 was observed in regions isolated from the rest of the country with low migration rates. The data obtained can be used in planning and organizing quarantine and anti-epidemic measures.

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