MATHEMATICAL SIMULATION OF THE SPATIAL SPREAD OF COVID-19 WAVES IN RUSSIA

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I. INTRODUCTION

Problems related to the COVID-19 epidemic are of great interest around the world. The present work examines the processes of COVID-19 epidemic waves in Russia. There are assumptions that the main source of new infection carriers is Moscow and that the process of the virus' spread can be modeled by a kinetic equation. We develop our first results in [1]. The model under consideration makes it possible to judge the nature of the spread of a modern pandemic for some countries. For the first wave of the pandemic, the processes in Italy, Chile and Russia have been studied. Now the attention is paid on the epidemic events

in Russia for the second and third waves. The model has certain predictive capabilities, so the fourth wave is also studied.

II. THE SPATIAL SPREAD OF THE WAVES OF THE COVID-19 PANDEMIC IN RUSSIA BASED ON THE KINETIC MODELS FOR A ONE- and TWO-DIMENSIONAL CASES

This work consists of two main parts. In the first part, the previously obtained one-dimensional kinetic model is used to predict and clarify the nature of the spread of the waves of the pandemic over the territory of Russia. In the second part, the model is generalized to a more complex and realistic two-dimensional case.

Since it is assumed that in the mentioned countries there were the main centers from where the spread of infection throughout the country took place, it is possible to determine the delay in the development of the disease in individual regions and in the country as a whole. This makes it possible to make certain predictions for the nature of the subsequent waves of the pandemic.

This work is a continuation of our previous one, in which the developed model is tested for the different waves of the pandemic in Russia. The present paper in particular examines the development of the third wave in Russia. The center of the spread of infection is, as in previous cases, Moscow. This seems to correspond to the real picture. This wave is associated with a new strain of the virus, penetrating mainly from India through Moscow airports. For the third wave, a prediction was made in early July that the number of infections per day for Russia as a whole would decline by mid-July of this year. This forecast was confirmed. Based on the values of the parameters found in the study of previous waves, predictions are made about the rate of spread of the pandemic, as well as about the speed of the "recovery wave". An important conclusion is that the maximums of infection in Moscow and Russia are separated by approximately 3 weeks. Comparisons are made with the actual data.

For a more detailed and accurate description of the spatial distribution of the epidemic, a problem with a two-dimensional geometry corresponding to the maps of the countries under study, and primarily the map of Russia. To do this, we write down the kinetic equation in two-dimensional form and use a numerical method to solve it, and thus acquire the first results for this model. The beginning of the fourth wave is also considered.

REFERENCES

[1] Aristov, V.V.; Stroganov, A.V.; Yastrebov, A.D. Simulation of Spatial Spread of the COVID-19 Pandemic on the Basis of the Kinetic-Advection Model. Physics 2021, 3, 85-102. https://doi.org/10.3390/physics3010008.