

Research on The Effects of Refraining from Going Out in The Spread of COVID-19 by Using a Multi-Agent Simulation

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1. Introduction

In the past, governments have taken measures such as lockdowns and requests for people to refrain from going out when the number of people infected with COVID-19 increased. As a result of these measures, the number of new infected people was reduced, but the virus was not completely eliminated, and the number of new infected people increased again, the economy stagnated, and these measures became one of the reasons for the confusion and physical inactivity. This study focuses on the relationship between physical inactivity and infections and compares the number of infected people in the simulation of refraining from going out as in the past and that of not refraining from going out by using a multi-agent simulation.

2. Multi-Agent Simulation

The multi-agent simulation (MAS) is based on the idea that programs do exhibit behaviors entirely described by the program instructions. It is possible to simulate an artificial world inhabited by interacting processes, by relating an individual to a program. It is also possible to simulate by transposing the population of a real bio system to its artificial counterpart in which particular hypotheses can be explored by repeating experiments. Each organism of the population is represented as an agent whose behavior is programmed with all the required details.

3. Proposed Model

Figure 1 shows two virtual areas: the area on the left is the home or the area near it, and the area on the right is the workplace, school, or any other place where people go out and about. On weekdays, 80% of people are active for 8 hours in the right area (work or school) and spend the rest of the time in the left area (home). On holidays, people move to the right area for 24 hours to exercise, shop, or travel. However, on holidays, 60% of people go out if they do not refrain from going out, while only 30% of people go out if they do. The number of people is 5,000 and the simulation period is 2 months.

The scatter plot shows the agents, and the movement of the agents and the infection situation can be recognized as a video. The blue points are the susceptible agents. Each simulation is repeated 50 times and the average value is calculated.

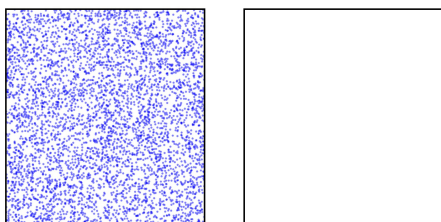


Figure 1: Two virtual areas. The left area has 5,000 agents.

In addition, the transmission of infectious diseases is shown in the flowchart in Fig. 2. In this study, it is considered that the immunity is impaired due to physical inactivity when not going out. Humans are about 60% more likely to contract an infectious disease when they are sedentary for 12 weeks than when they walk regularly. Therefore, in the simulation of not going out, the infection rate is 10% higher when people do not go out for two weeks.

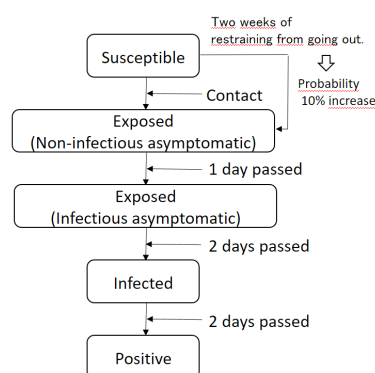


Figure 2: Flowchart of the transmission of infectious diseases.

4. Results

The results of the 50 simulations showed that the number of all positive cases was 137.8 in the case of refraining from going out and 142.2 in the case of not refraining from going out, and the number of new infected people at the peak was 48.92 in the case of refraining from going out and 51.68 in the case of not refraining from going out. There is little difference in these items between the two simulations. However, the peak period was 23.88 days later in the case refraining from going out and 20.02 days later in the case not refraining from going out, and the number of new infected people after two months was 27.04 in the case refraining from going out and 8.46 in the case not refraining from going out. Therefore, the peak period is earlier when people do not refrain from going out, but after two months, the virus is reduced considerably.

4. Conclusion

In this study, the number of people infected with COVID-19 was compared between going out and refraining from going out. Then, two types of simulation models were created by MAS. One is a simulation in which people do not refrain from going out and people go out freely. The other is a simulation in which people refrain from going out and the infection rate increases due to physical inactivity. As a result, the peak period is earlier when people do not refrain from going out, but the virus is considerably reduced after two months.