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Technical Report 4

Doubling time as a measure of epidemiological spread in COVID-19

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Highlights

- An exponential increase of cases leads to a rather shorter doubling time.
- The shorter the doubling time, the faster the growth of infection.
- Doubling time is important along with other factors that affect the disease progression.
- Reproductive number (R_0) and actual transmission rate (R_t) which are related to doubling depend on local conditions.
- During the time when preventive measures are relaxed, doubling time should be identified as a key epidemiological indicator in prevention of COVID 19.

Background

SARS-CoV-2 is simply transmitted from person to person, possibly through large droplets and contaminated surfaces. Being a novel human virus, it does not impart any pre-existing protection in the population nor an effective control measure, thus the number of cases has increased exponentially in the world, consequent to an incubation period estimated to be on average of 5-6 days but that which can go up to 14 days. In an exponential increase of cases, the 'increase' becomes higher as the accumulating cases become more, which in turn would lead to a rather shorter doubling time. The other epidemiologic indicator which is related to this phenomenon is the reproductive number (R_0) or the number of susceptible individuals infected by a single positive person, which usually ranges between 1.5 and 3.5, probably dependent on local conditions (1). Another parameter well blended with R_0 is the R_t, which is the actual transmission rate. There is community transmission when infections in individuals without a travel or contact history are identified. Hence, the objective of this short article is to give an overview of

the doubling time along with the other two epidemiological indicators, for the public health experts to take timely control measures.

Doubling time and the related epidemiological indicators

• Doubling time

Doubling time can be defined as 'the time needed to double the cases from an initial figure' (2). If there is a fixed rate in the exponential growth, the doubling occurs at fixed time intervals. For example, if the doubling time is five days and 100 cases were there on day 1, it would become 200 by day 6 and 400 by day 11 (2). Doubling time of a disease is an essential epidemiological measure, which reflects several critical aspects of an epidemic at a glance, such as the health threat and influence of the environmental, social, political and administrative factors. Further, it is found to be different from country to country (3), and therefore when doubling time is compared between countries, it is essential that country-specific characteristics related to the environment (e.g. sunlight, humidity, etc.), socio-cultural (behaviour of the people and the level of social responsibility of individuals, etc.), economic and political (high political commitment and timely decisions according to the experts' evidence-based opinions, etc.) aspects are considered. The longer the doubling time, more flattened the epidemiological curve would be, reflecting the success of interventions of a country

• The exponential growth of cases

When the rate of the change is proportional to the current size, growth is termed as an exponential growth (3). Hence, in an exponential increase, the 'increase' becomes higher as the accumulating cases become more. In epidemics with such exponential growth, the numbers start increasing slowly and then dramatically over time. At the beginning, people do not detect or feel the numbers and when they do, the damage has already been done.

• Reproductive number (R_0)

A critical point ruling in the COVID-19 pandemic is estimating exactly how contagious the virus is. One important epidemiological parameter is the basic reproductive number (R_0). It is the expected number of secondary cases produced from a single infectious individual in a completely susceptible population (4). This parameter helps to understand the disease dynamics and initiate relevant mitigating measures. An R_0 value <1 indicates that cases are decreasing, while a value more than 1 would indicate a rise in the infected cases (5). According to latest studies, the R_0 of COVID-19 ranges between 2 and 2.5, while during the early outbreak in China, the virus has spread with an R_0 of 5.7. Public health experts use this parameter along with doubling time to take necessary control measures (6).

• Actual transmission rate (Rt)

Another parameter that is well connected with R_0 is the R_t; the actual transmission rate. Unlike R_0, R_t gives a higher figure at any given time "t". This is very important for the policy makers to implement their activities, since R_t provides a snapshot view at a given time of a specific geographic area. The University of Hong Kong recently published their decrement of R_t with time, which succeeded with preventive interventions. As shown in Figure 1, the R_t value which was 2.3 by 3 February has been reducing until the second rise which reported imported cases in March, and thereafter steadily declining to 0.7 (7).

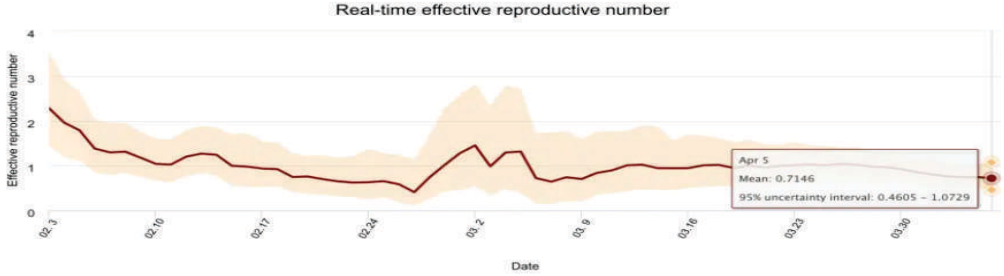

Figure 1: Actual transmission rates (Rt) of COVID-19

Source: The University of Hong Kong's real-time Rt dashboard

Doubling rates of COVID-19 in Sri Lanka

After detection of the first locally confirmed COVID-19 case on 11 March, Sri Lanka reported a relatively higher doubling time compared to other countries, such as Italy, the USA, Japan, UK and Australia until the third and fourth week of March. Even with effective control and preventive measures being in place, it fluctuated in the month of April, but thereafter had maintained a relatively low value towards the end of the first week of May.

Ironically, though Sri Lanka faced a sudden surge of infected cases from navy personnel, it has not yet significantly affected the rise of doubling time (Figure 2).

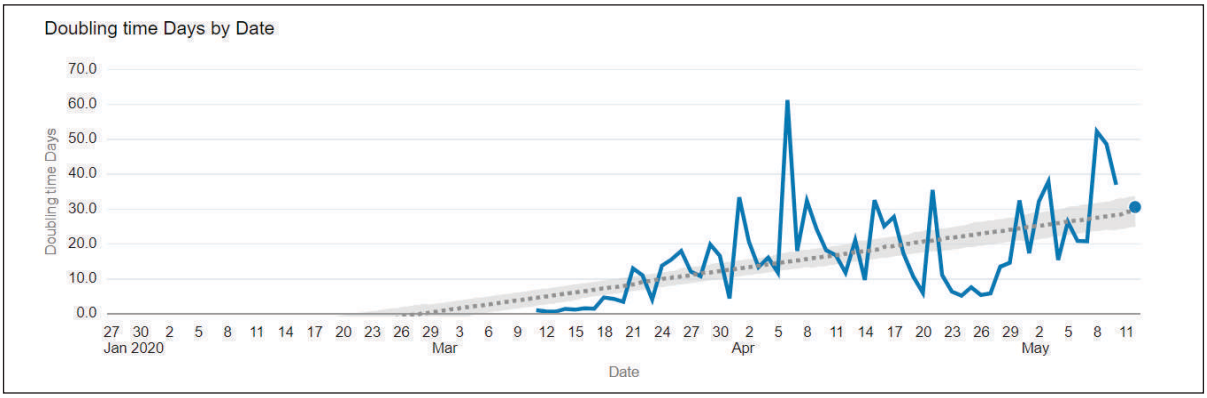

Figure 2: Doubling rates in Sri Lanka

Source: COVID-19 Situation Report for Sri Lanka

Nevertheless, one needs to be more conscious of the changes in doubling time in Sri Lanka, since it reflects the effectiveness of the measures taken to curb the spread of the disease in the community. The doubling time depends on the propagation of the disease from the current status of cluster stage into community transmission, thus stringent measures should be in place to identify the increasing number of cases through strong surveillance and infection prevention by practising good health habits. Most crucially, this concept must be well understood by all the citizens so that all can act collectively.

Comparison of the doubling rate of COVID-19 of Sri Lanka with other countries

The doubling rate of seven countries (USA, Republic of Korea, Italy, Japan, Iran, Australia and UK) are shown in Figure 3.

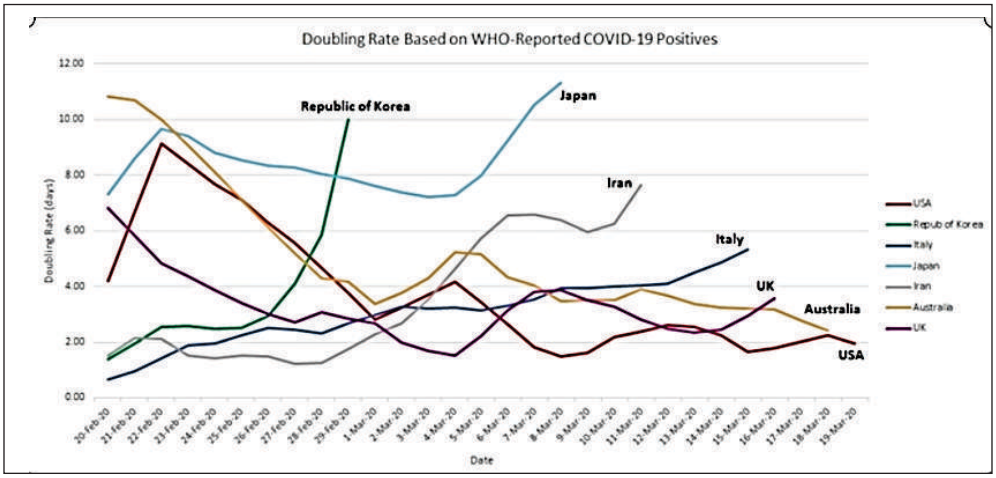

Figure 3: Doubling rates of selected countries (2)

According to this graph, the USA has been having a relatively high doubling rate initially, compared to the Republic of Korea, Italy, Japan, Iran, Australia and UK. Even though USA reported the lowest doubling rate on 19 March compared to all other countries, the initial surge has mattered. Australia and Italy have reported decreasing trends in the doubling rates and have been maintaining it around for one month. Doubling phenomenon in Japan is completely different when compared to other countries, as it had shown a rapid rise, a decline and next a rise greater than its initial surge. The Republic of Korea depicts a completely different picture compared to other countries, with a steep rise reported within the first week. It should be kept in mind that many factors may affect the doubling rate of the virus in a country. These changes may be the result of the public health interventions, social distancing and national policies. Such interventions differ between countries, and therefore the trend of doubling time is also likely to change accordingly.

Applicability of the evidence to Sri Lanka

Several studies have estimated differential rates of doubling time for COVID-19 using a wide range of statistical and modelling methods. Hence, as a measure of spread, the doubling time is important especially when considered along with other factors that affect the disease progression. Further, when preventive mechanisms are relaxed with re-opening of the country, the doubling time of COVID-19 should be identified as a key epidemiological indicator. Monitoring and evaluation of the surveillance mechanism is another main strategic action where information on the doubling time is useful. Therefore, the accuracy, transparency and timeliness of the data flow chain need to be ensured while conducting activities for strengthening the public health arm of the country.

Author Declaration

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