Effect of the Songkran festival on COVID−19 transmission in Thailand

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In late December 2019, China declared that there were some citizens, in Wuhan, infected by an unknown pathogen[1]. The number of infectious patients has increased rapidly, not only in China but also in other countries throughout the world. Thailand reported the first coronavirus disease 2019 (COVID-19) infected case, who was a traveler from Wuhan, China, on January 3rd, 2020. Until March 10th, 2020, the number of cases in Thailand was 53[2,3]. All of these detected cases were travelers from high-risk countries and Thai people who were in very close contact with travelers. These detected cases had been isolated and quarantined so that there was no sustained chain of transmission in Thailand before March 10th, 2020.

The Songkran festival in the middle of April is a large annual event for both Thai and foreign visitors in Thailand. A great number of tourists around the world visit Thailand and participate in this festival every year. In this event, a crowd splashes water on others and put liquid chalk on their faces. In the pandemic situation, these activities may lead to a large number of infected cases.

Although the Thai policymakers have recently decided to ban the Songkran festival this year in order to mitigate the COVID-19 transmission in Thailand, however, currently there is no estimate of how much the festival could affect the COVID-19 transmission. In this study, we, therefore, constructed a susceptible-exposed-infectious-recovered model to estimate possible COVID-19 transmission during the festival. All of the epidemiological parameters in the model were based on the transmission dynamics in Wuhan, China[4] (see the section of the disease transmission model below). We used money expense data during the festival last year to roughly approximate to how frequently people contacted each other during the festival. We found that Thai people spend more money on this event up to 6 times compared to the average daily expense[5]. These extra expenses could indicate higher human contact frequency during the festival.

Figure 1 shows the number of cumulative cases (not including the 53 confirmed cases reported on March 10th) in a scenario in which there is a sustained chain of transmission that starts on March 10th, 2020. We estimated the number of cumulative cases for the

best-case (the basic reproduction number, $R_0=1.2$) and worst-case ($R_0=2.2$) scenarios. The result indicates that the festival could accelerate COVID-19 transmission in Thailand. When compared with the based-line case (no Songkran festival, red lines), we found that the festival can contribute up to 1.3-100 times higher number of infected people after the festival, depending on R_0 and the contact frequency during the festival. Our finding supports the policymakers' decision to ban the Songkran festival in Thailand this year.
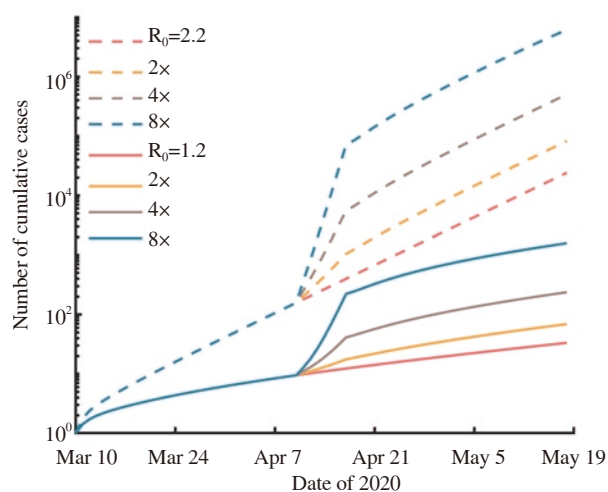

Figure 1. The estimated number of cumulative cases. Solid and dotted lines are the results of the best- and worst-case scenario, respectively. Lines with 2×, 4×, and 8× indicate the results when the human contact frequency during the festival increase by 2, 4, and 8 times, respectively.

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Table 1. A summary of parameters and their values used in the model.

Symbols	Definitions	Values
S	Number of susceptible individuals	Initial value, $S = N - 1$
E	Number of exposed individuals	Initial value, $E = 0$
I	Number of infectious individuals	Initial value, $I = 1$
R	Number of removed individuals	Initial value, $R = 0$
N	Population size in Thailand	6.904×10^7
σ	Incubation rate	1/5.2 (per day)
γ	Recovery rate	1/2.3 (per day)
R_0	Basic reproduction number	1.2, 2.2

The disease transmission model: We used the following susceptible-exposed-infectious-recovered model to estimate the effect of the Songkran festival on the COVID-19 transmission in Thailand:

$$\frac{dS}{dt} = -\frac{\beta I}{N} S$$

$$\frac{dE}{dt} = \frac{\beta I}{N} - \sigma E$$

$$\frac{dI}{dt} = \sigma E - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

Where S, E, I, and R are the number of susceptible, exposed, infectious, and removed individuals, respectively. σ is a rate that is inversely proportional to the mean incubation period and γ is a rate that is inversely proportional to the mean infectious period. $\beta = R_0 \gamma$ is a disease transmission rate. The Songkran festival period was considered from April 11th to April 17th. During this period, the human contact frequency increases, as a result, the disease transmission rate is higher than usual. In this study, we investigated three scenarios in which the rate of COVID-19 transmission during the festival increases by 2, 4, and 8 times. Table 1 summarizes the parameters and their values used in the model.

Conflict of interest statement

We declare that we have no conflict of interest.

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Authors´ contributions

CM conceived and designed the study. NCJ and CM conducted the study and drafted the manuscript. PS collected data. All authors were responsible for analyses and data interpretation.

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