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Short Communication

Features and transmission dynamics of SARS-CoV-2 superspreading events in Taiwan: Implications for effective and sustainable community-centered control

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1. Introduction

Although most of the countries worldwide are facing the thunder of the third or fourth waves of coronavirus disease 2019 (COVID-19) and new cases are ticking upward every day, Taiwan remains nearly clean from new local cases as of December 2020. This research letter aims to demonstrate the epidemiological features and transmission dynamics of COVID-19 superspreading events (SSEs) in such a low-incidence country (Taiwan) during the pandemic.

2. Methods

Information of all COVID-19 confirmed cases were collected from the Taiwan Centers for Disease Control (Taiwan CDC), which provided an online platform for the transparent information of all confirmed cases with severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection.[1] Among all cases, there were 14 infector-causing clusters with available numbers of susceptible contacts identified. The definitions of transmission pairs, serial interval, secondary attack rate (SAR), and SSEs were taken from previous studies.[2,3] Estimated basic reproductive number (R_0) and dispersion parameter (k) were calculated by the negative binomial distribution, as described by Blumberg and Lloyd-Smith et al.[4,5] The IBM SPSS statistics (version 27.0) was applied for the negative binomial distribution, whereas R version 4.0.4 (Lost Library Book) and SAS/STAT software were used to recheck the probability of estimated serial interval and R_0 value.

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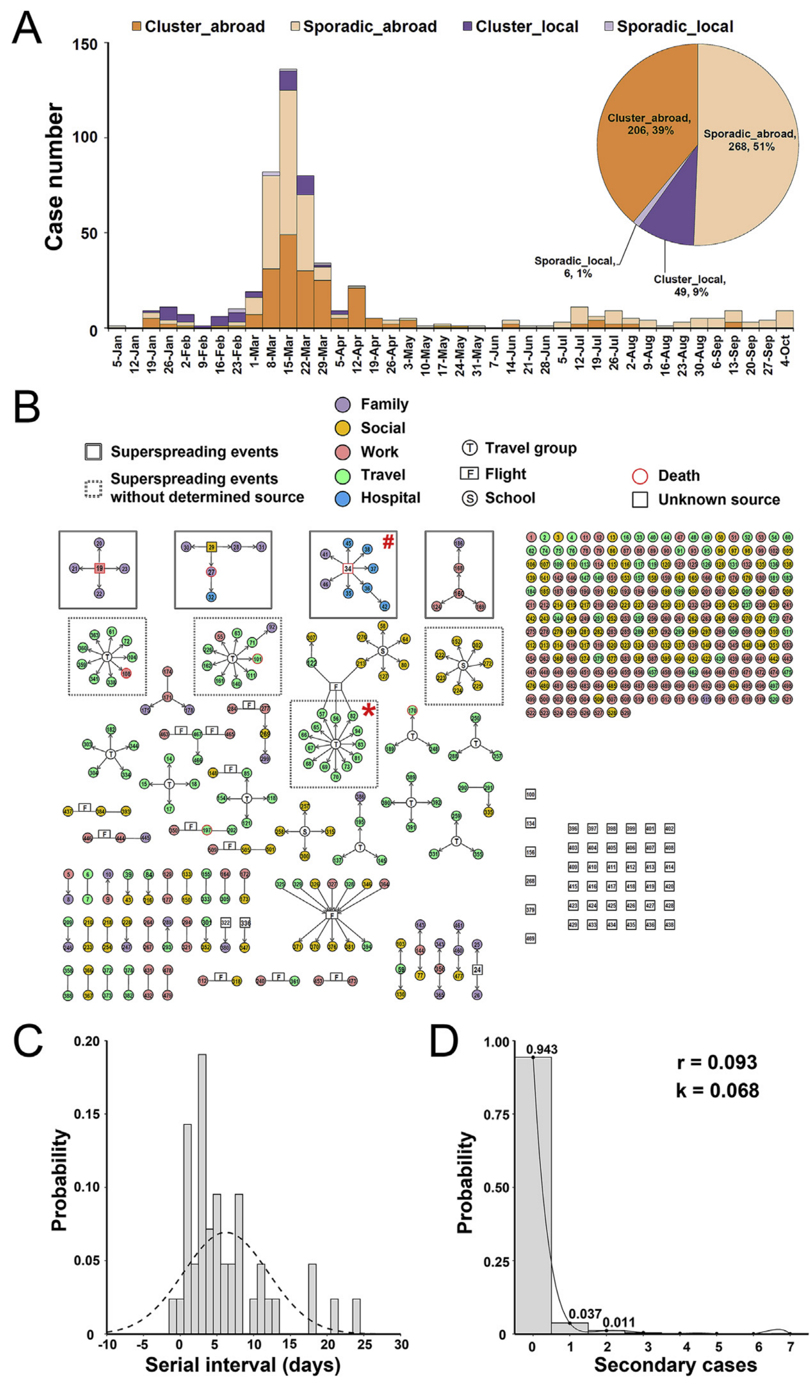

Figure 1 Cases and clusters of COVID-19 in Taiwan. (A) Epidemic curve of weekly case numbers of laboratory-confirmed COVID-19 in Taiwan by the symptom onset date (n = 529). Clusters are expressed in different colors according to their source characteristics. (B) Chains of SARS-CoV-2 transmission were initiated by local or imported cases. The transmission pair was defined as an infector who had a laboratory-confirmed infection with an infectee who reported a single epidemiological link with an infector. The serial interval is the period between the symptom onsets of the infector and infectee. Clusters marked in black square indicate the SSEs with an identified index case, given a superspreading threshold of four secondary cases. Clusters marked in black dotted line square are the SSEs without a determined source. The number in each circle or square represents the official case number designated by Taiwan CDC. # stands for a hospital cluster; * stands for the largest SSE in a travel group. (C) Serial interval distribution of 42 COVID-19 pairs, with the symptomatic infector—infectee pairs fitting normal distribution. Seven asymptomatic pairs (either as infector or infectee) were excluded because of the lack of identifiable symptom onset dates. (D) Among the 30 infectors, the probability for an infector without causing any offspring infection is 0.943. The estimated R^o and *k* are 0.093 and 0.068, respectively. COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus-2.

3. Results

As of October 4, 2020, there were 529 laboratory-confirmed cases reported by Taiwan CDC, with most cases (474, 89.6%) being the imported ones. Among them, 255 (48.2%) were associated with epidemiologically linked clusters. The surge of daily new cases first developed in March, when the world was in the early pandemic phase and the curve remained flat after then (Fig. 1A). Among all confirmed cases with traceable contact source, four SSEs with another four possible SSEs were recorded with two identified super spreaders (Fig. 1B). Two SSEs developed in the household setting, and three developed in the household-like environment (e.g., tour groups). The largest cluster was found in a tour group traveling to Turkey, including 14 persons. All of them were diagnosed in the quarantine period by RT-PCR test, and only one secondary offspring infection was recorded. The largest SSE in the local setting is a nosocomial cluster in a medical center, including nine patients with one identified superspreader, who is a 57-year-old woman with an underlying congestive heart failure. The crude SAR among 14 clusters was 1.0% (34/3,303), and only three clusters showed a secondary offspring infection (Fig. 1B). In total, 24 confirmed cases were of children; all of them were adolescents (10—18 years old), except two who were at preschool age (0—4 years old). Most of the pediatric cases were imported cases, except four were local infection. Among the local cases, two were household transmission and the other two belonged to the same school cluster. Only one patient had an epidemiological link to an SSE.

As for the transmission dynamics, the mean serial interval among 42 infector—infectee pairs was 6.2 days (95% confidence interval: −5.07 to 17.9) (Fig. 1C). By the negative binomial distribution, the probability for an infector without causing any offspring infection was determined as 94.3%. Moreover, the estimated R_0 and k were 0.093 and 0.068, respectively, both of which are much lower than those reported in studies from other countries (Fig. 1D).

4. Discussion

We found in this study that the transmission dynamics of SSEs in Taiwan is quite different from other countries with larger outbreaks.[6—8] First, in other countries, SSEs usually developed in the public events or places, thereby causing a wide offspring infection. In contrast, SSEs in Taiwan mainly developed in household or household-like settings. The mean serial interval of the clusters is close to that in other studies, meaning that the virological factor of SSEs appeared the same between Taiwan and other countries.[6—8] However, the SAR and estimated R_0 were much lower than those of other countries estimated in a previous study (Mean R_0 is 2.5 in Wuhan, China, 5.9 in the United States of America, 3.9 in the United Kingdom, and 4.6 in Italy).[9] This observation suggested that despite the presence of SSEs in Taiwan, the impact of SSEs was mitigated significantly by advanced deployment prevention strategies. Contrariwise, intra-school transmission played an essential role in the explosive community outbreak.[10] Because Taiwan did not face the exact explosive outbreak of COVID-19 in the community; the school closure policy was never executed in Taiwan. However, despite an extremely low-incidence of local transmission, a small-scale school cluster was still identified.[11] Taken together, it is possible to keep schools open during the pandemic with effective community-centered public health interventions.[12,13]

Two important features of SARS-CoV-2 dissemination are pre-symptomatic and fomite transmission, which made the prevention or early detection of SSEs even more challenging.[14,15] Mitigating SARS-CoV-2 dissemination requires multidisciplinary strategies. Because of the geographic proximity, Taiwan CDC started a close monitoring on the early outbreak in China in December 2019 and enforced an active surveillance on passengers returning from Wuhan in early January 2020. COVID-19 was defined as a notifiable disease on January 15 2020. The government has banned the exportation of the facial mask since January 24, 2020. Quarantine and active contact-tracing policy for travelers back from the epicenters in China started in March 2020. A behavior study conducted in northern Taiwan found that at least 50% of people spontaneously wore a facial mask in public places since early February 2020.[16] Furthermore, the government implemented a policy of mandatory universal facial masking in public places since April 2020. Effective quarantine and contact-tracing policy that can early detect the potential viral spreaders in the community was also implemented.[17] The early and universal facial masking policy will prevent pre-symptomatic transmission if any infected cases already encountered other people. In this way, the risk of the development of SSE can be reduced to the minimum in the public environment.[18]

Although SSEs were still recorded, with the deployment of abovementioned bundle-enhanced, multi-strategic policies, Taiwan has sustained a good disease control without any large community outbreak since early 2020. With a low community disease burden, health care facilities could be protected with a less risk for a nosocomial outbreak while ensuring continued medical service to patients. According to this study's results, we anticipate that Taiwan will sustain a good control if these mandatory policies can be properly and continuously executed.

SSEs with limited local transmission were observed in Taiwan. The community-centered protection focusing on active contact-tracing, strict quarantine policy, reinforcement of hand hygiene, and most importantly, universal facial masking could show an effective impact on disease prevention in both community and hospital settings. Due to limited treatment modalities and uncertainty in vaccine effectiveness, for countries that are still suffering from considerable disease burden and tense medical capacity, these non-pharmacological, public health interventions remain to be the gem of controlling COVID-19 spread.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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