Did Visitors Cause Outbreaks of COVID-19 Dominated by the Original Strain? Ex Post Evaluation of Long-Distance Travel Bans

Junko Kurita[1], Yoshitaro Iwasaki[2]

1) Department of Nursing, Faculty of Sports & Health Science, Daitobunka University, Saitama, Japan

2) CEO, Iwasaki Industrial Corporation, Kagoshima, Japan

Corresponding author: Junko Kurita, kuritaj@ic.daito.ac.jp

Keywords: airport users, COVID-19, effective reproduction number, Go To Travel Campaign, hotel visitors, mobility

**ICMJE Statement**

Contributor JK was responsible for the coordination of the study and analyzed the data. YI set the data. All authors contributed to the writing of the final manuscript.

Abstract

Background: Long-distance travel was banned while the SARS-Cov-2 original strain was dominant. Nevertheless, that policy had not been adequately evaluated.

Object: We evaluated long-distance travel effects on infectivity, considering climate conditions, mobility, and countermeasures including the “Go To Travel Campaign” (GTTC) travel subsidy policy.

Method: We regressed the effective reproduction number R(*t*) on long-distance travel, temperature, humidity, mobility, and countermeasures such as the emergency state declaration or GTTC in Kagoshima prefecture. The number of airport limousine bus users represented long-distance travel volumes. The study assessed data from May 16, 2020 through February 2022, before variant strains emerged and became dominant.

Results: Estimation results indicate declining infectivity along with long-distance travel volumes. Moreover, R(*t*) was lower during GTTC.

Discussion and Conclusion: Policies banning long-distance travel had little legitimacy or rationale. Long-distance travel with appropriate infection control measures did not spread COVID-19 infection in tourist areas.

## Introduction

As countermeasures against the COVID-19 outbreak in Japan, school closures and voluntary event cancellations were required from February 27 through March. Large commercial events were also cancelled. Subsequently, a state of emergency was declared from April 7 through 25 May, requiring voluntary restriction against going out from homes and requiring the shutting down of businesses serving consumers. During this period, the first peak in the outbreak was reached on April 3. Another peak then emerged on July 29, as shown in Figure 1. The so-called “Go To Travel Campaign” (GTTC) started on July 22, with 50% subsidized travel and coupons issued for shopping at tourist destinations. The policy was aimed at reinforcing sightseeing businesses, even though such a measure might have expanded the outbreak. Thereafter, GTTC continued through December, by which time a third wave had emerged. The third wave in December was larger than either of the prior two waves. Therefore, GTTC was implicated as the main underlying reason for the third wave [1].

However, although results were mixed, study results suggested that COVID-19 was associated with climate conditions, at least in China [2–4]. Other researchers doing cross-sectional international comparisons in Europe countries found no association between climate conditions and surging dates of COVID-19 outbreaks [5]. If the association was valid for Japan, then GTTC might not be the main reason for that third wave in winter.

Moreover, mobility was inferred as the main cause of the outbreak dynamics, at least for the first wave in Japan [6], as it was throughout the world [7]. One earlier study [8] showed that non-pharmaceutical interventions including lockdowns strongly reduced transmission in at least 11

European countries through April. However, another study [9] of 131 countries found that the introduction and relaxation of lockdowns or movement restrictions had only limited effects on infectiousness, except for public event bans, although their data were limited to data extending only to the end of July 2021. Another study [10] indicated that strict movement restrictions in Argentina from March were effective at reducing mobility, but not for mitigating the outbreak. These mixed results suggest that such countermeasures might not significantly affect mobility.

In fact, no reported analysis examined how the number of sightseeing visitors or how long-distance travel affects outbreak situations in rural areas. One might expect that such information might be less available for epidemiological analysis. Some annual or monthly data related to travelling or sightseeing might be generally available, but such good luck seems unlikely. Moreover, such data would be too aggregated, with too few data to support statistical analyses for a short period of less than one year. Fortunately, epidemiologists, statisticians, and companies managing resort hotels and buses to airports in rural areas can provide data collaboratively. In fact, daily data of bus users from airports and visitors to these hotels are available for many areas in Japan. Therefore, the hypothesis that sightseeing visitors and long-distance travelers spread outbreaks in rural areas can be tested directly. This hypothesis served as the rationale for ceasing GTTC and for banning long-distance travel during the first and second states of emergency. Nevertheless, that rationale has been neither analyzed nor confirmed to date.

Therefore, the object of this study was direct examination of the hypothesis supporting the rationale and legitimacy of the policy in Kagoshima prefecture, Japan, which is located in southern Japan, but north of Okinawa, as shown in Figure 2. For that area, one airport was used for commuting with more urban areas such as Tokyo and Osaka. Particularly, this collaboration includes leading tourist industry companies in Kagoshima and epidemiologists using valuable data that have never been examined, which can contribute to more insightful consideration and policy evaluation.

## Methods

Valuable data about the daily numbers of Kagoshima airport limousine bus users was provided by Iwasaki Industrial Corp. of Kagoshima. However, the information was not complete. Some airport users accessed to or commuted from the airport by taxi, private car, or rental car. Moreover, some tourists visited Kagoshima without using an airline: by train, car, bus or ship. However, most tourists from Tokyo or Osaka, or other urban areas, probably used airlines to visit Kagoshima. Therefore, although available information was not verified completely, we infer that available information accurately reflected a complete picture of movement.

The study period was defined as June 20, 2020 through February 2021. Before this period, COIVD-19 patients had been confirmed only sporadically. Therefore, R(*t*) cannot be estimated as stable. After this period, the Alpha variant strain emerged and dominated up to 35% of all cases throughout Japan by the end of March [11]. Its infectiousness was estimated as 35–90% higher than the original strain [12–15]. Such a large difference in virus characteristics might affect estimation for our objectives. Therefore, we limited the study period to the times before emergence of the Alpha variant strain.

The numbers of newly confirmed patients each day were reported by the Kagoshima prefecture office from May 13, 2020 through February 2021 [16]. Estimation procedures for the effective reproduction number were the same as those used for an earlier study [17]

We used the average temperature and relative humidity data for Kagoshima during the day. Temperatures were measured in degrees Celsius. We obtained data from the Japan Meteorological Agency (https://www.data.jma.go.jp/gmd/risk/obsdl/index.php).

Additionally, we identified several remarkable countermeasures in Japan: four state-of-emergency declarations, a travel campaign, and school closure and voluntary event cancellation (SCVEC). The latter, SCVEC, extended from February 27 through March in 2020: this countermeasure required school closure and cancellation of voluntary events, and even cancellation of private meetings. The first state of emergency was declared on April 7, 2020. It ceased at the end of May. It required school closures, shutting down of some businesses, and voluntary restriction against going out. To subsidize travel and shopping at tourist destinations, GTTC started on July 22, 2020. It was halted at the end of December 2020.

The second state of emergency was declared on January 7, 2021 for the 11 most-affected prefectures. This countermeasure required restaurant closure at 8:00 p.m., with voluntary restrictions against going out, but it did not require school closure. It continued until March 21, 2021.

To clarify associations among R(*t*) and GTTC or variable data in addition to climate, mobility, and countermeasures except for GTTC, we used ordinary least squares regression to regress the daily R(*t*) on daily dummy variables for GTTC, and daily data of airport limousine bus users and visitors at the resort hotels, as well as dummy variables for daily climate, mobility, and dummy variables for countermeasures. We used mobility data provided by Google, which showed places of six types: restaurants, shopping mall or amusement centers; grocery stores or pharmacies; parks; transition areas; workplaces; and homes (https://www.google.com/covid19/mobility/). The data show mobility comparisons with a base day. A number of 100 was assigned if the number of persons staying at a type of place was the same as the base day.

We expected the signs of the explanatory variables as follows: airport limousine bus users and visitors at the resort hotels or GTTC increased infectivity if the policy banning long-distance travel was rational. Countermeasures such as the emergency status or SCVEC were presumed to decrease infectivity. We adopted 5% as the significance level.

## Results

Figure 1 shows newly confirmed cases of COVID-19 including asymptomatic cases in Kagoshima during May 16, 2020 – February 28, 2021. The initial case was detected on May 16. However, data were sporadic in the initial phase. From June 2020, cases were reported continuously.

Figure 3 presents the estimated R(*t*) and its 95% confidential interval. Before June 2020, it was too large and volatile because very few cases were reported at that time. After June 2020, because new cases were reported almost daily, R($t$) changed to become smaller number, exhibiting less volatility. The largest peak was that of November 2020, while GTTC was operating.

Figure 4 portrays the number of the airport limousine bus users. The main peak of airport limousine bus users occurred before the outbreak emergence. During April and May, 2020, when the first emergency status was declared, it decreased considerably. In fact, it was zero in September 2020, when the airport was closed because a typhoon struck the area.

Table 1 presents the estimation results obtained when the study period was limited to June 2020 and thereafter. Climate conditions, temperatures and humidity, were not found to be significant at all. Places were not found to be significant in the shorter period except for restaurants and grocery stores. One can infer that going to a restaurant increased infectivity and that, by contrast, going to a grocery store, perhaps to prepare to "stay at home" reduced it. This result might indicate that a "stay at home" policy including a lockdown or voluntary ban against going out, as practiced in Japan, was legitimate. However, staying at "home" itself or going to a "workplace" were not found to be significant, even though these were negative. The first and second states of emergency and GTTC were found to be negative and significant. Particularly, the estimated coefficients of these variables were quite large.

The number of the airport limousine bus users significantly reduced infectivity if one disregards data acquired before May 2020. If this period is include, the results are negative but not significant.

Discussion

Estimation results for GTTC and the number of the airport limousine bus users indicate that promotion of long-distance mobility might decrease infectiousness. That finding might be inconsistent with a legitimate policy banning long-distance travel including cessation of GTTC. Our findings suggest that during sightseeing or long-distance travel, tourists and visitors and hosts might have much more conscientiousness about infection control and thus be less likely to infect others than when they are in their home town. In other words, people in their home town might have less consciousness and therefore be more likely to be infected. Therefore, discouraging long-distance travel might actually lead to worse infections in one's home town.

This finding is consistent with those of earlier studies [18–19]. One found that GTTC reduced infectiousness. The other found that events with an audience might not raise infectiousness compared to events without an audience.

Another study [20] using patient data of two types (onset date and the date of testing positive) found that travel-associated COVID-19 incidence during July 22–26, when GTTC had started, was much higher than during either an earlier period of June 22 to July 21 or July 15–19 or June 22 – July 21 in terms of the incidence rate ratio (IRR). That study also compares the period of August 8–31.

We have identified some odd points in the report of that study. The first is that the proportion of people with a travel history during the GTTC period was almost comparable to those of people during the two prior periods. Especially when the earlier period was defined as July 15–19, the proportions of people with a travel history among patients with an available onset date were smaller for the GTTC period than during the prior period. However, the authors found significantly higher incidence in the GTTC started period. Their finding might merely reflect the fact that the total number of patents in the GTTC period was higher than during the prior period. In other words, they did not control for the underlying outbreak situation and therefore found an incorrect association. Use of the IRR would be valid if the underlying outbreak situation other than the examining point were the same in the two considered periods. Therefore, application of IRR might be inappropriate for this issue. At least, controlling the potential differences in the outbreak situation is expected to be necessary. The underlying outbreak situation, unrelated to GTTC, was reflected in the number of patients without a travel history or any sightseeing. To control the underlying outbreak situation, analysis of the share of patients with a travel history or sightseeing might be one procedure. However, that share did not increase markedly during the GTTC starting period. This fact indicates that the authors' results and conclusions are misleading.

A second point is that the authors of that report referred to the period of August 8–31, when GTTC was continuing. The proportion of patients with a travel history or tourism was much smaller than in the GTTC period or the prior period. Although the authors did not compare incidence during the period with that of either the prior period or the GTTC period, the rate of incidence during the period in August was probably lower than in other periods. In fact, some patients using GTTC might have been included in the period, as described above. Their inclusion might be inconsistent with the authors' conclusion.

A third point is that we observed the peak of newly infected persons as July 23, the GTTC starting date, in the entirety of Japan. Therefore, we infer that GTTC might have reduced infectiousness. We also consider climate conditions. At around the end of July, the rainy season in Japan ceased: summer began, with high temperatures. At least, GTTC was insufficient to raise the number of patients and cancel out benefits from the improved climate conditions. Taken together, these points suggest that GTTC might not be the main factor determining the course of the outbreak.

Moreover, if GTTC has a strong effect on the outbreak, then GTTC must also increase the number of patients without any travel history. For example, one can consider a patient traveling using GTTC on July 22 and 23, with onset on July 24. This patient had a travel history with GTTC, but was not included in a group of patients with a travel history whose onset date was included in the GTTC started period of July 27–31. Nevertheless, presymptomatic patients are well known to have infectiousness during the symptomatic period [21]. This patient might infect staff members of hotels or persons with visiting areas. Yet they had no travel history. Their onset dates were in July 27 and 28. Therefore, they were included a group of patients without a travel history in the GTTC start period of July 27–31. Therefore, GTTC certainly increased the number of patients without a travel history, but did not increase patients with a travel history in this case. Therefore, when considering the GTTC effects, one must check the number of patients irrespective of their travel history.

Finally, it is noteworthy that this study could be done in mid-of March or at the end of March 2021, if we had prepared those data. We found the same results as this study. In fact, this study was performed in 2022, although similar research without the valuable data used for this study was posted in January 4, 2021. We obtained the same results for GTTC [18]. In general, ex ante policy evaluation is necessary, but it was very difficult to estimate its effects precisely. By contrast, ex post evaluation performed as soon as possible can be done if preparation for it had had been arranged before policy activation. If such preparation had been done, a policy banning long-distance travel without any legitimate rationale could have been prevented in 2021 and thereafter.

For this study, we used daily airport limousine bus users as a proxy of daily airport users including those who did not use limousine buses because daily airport user data were not available. However, monthly airport user data were published [22]. Therefore, we can check the representativeness of airport limousine bus users for airport users on a monthly basis. Correlation between monthly airport limousine bus users and airport users during 2020 and 2021 was 0.9881 ($p = 0.000$). Therefore, we can infer that airport limousine bus users constitute a good proxy of airport users. Moreover, even though bullet train or bus services were also available as mean of transportation to Kagoshima from neighboring or nearby prefectures, airlines were the only means of transportation to Kagoshima from areas with large populations in Japan such as Osaka and Tokyo.

Therefore we can infer that airport limousine bus users are a good proxy of long-distance travel for Kagoshima.

The present study has some limitations. First, this study specifically assessed Kagoshima. For that reason, it remains unclear whether the same results would hold for other places or for the entirety of Japan.

Second, we particularly examined the original strain, which might be less infective than the Alpha variant strain [12–15], and subsequently dominant Delta and Omicron variant strains [23–26]. The effects of a policy banning long-distance travel might have been different under those mutated strains.

Third, if complete daily information about long-distance travel to Kagoshima prefecture were available, obviating the use of data focusing on only part of them, the implications might differ from ours. We consider that our data reflect the complete information precisely, but we cannot prove it.

Fourth, regression analysis such as that used for this study does not demonstrate causality. Although we interpreted the number of airport limousine bus users as decreasing infectivity, lower infectivity reinforces the number of airport limousine bus users. One must interpret the results carefully.

## Conclusion

We demonstrated that GTTC or the increasing of tourists and long-distance travel visitors might not raise COVID-19 infectiousness. Therefore, the policy banning long-distance travel including cessation of GTTC was neither fair nor rationally justified.

The present study is based on the authors' opinions: it does not reflect any stance or policy of their affiliations.

Acknowledgments

We acknowledge the unique data providers as well as the great efforts of all staff at public health centers, medical institutions, and other facilities fighting the spread and destruction of COVID-19.

Ethical considerations

Information about patients used for this study was collected under the Law of Infection Control, Japan and published by Kagoshima prefectural office [16]. Iwasaki industrial company provided airport limousine bus users in business recorded. There is therefore no ethical issue related to this study.

Competing Interest

No author has any conflict of interest, financial or otherwise, to declare in relation to this study.

## References


1. The Nippon Communications Foundation, Japan to Suspend Go To Travel Program Entirely Politics Dec 15, 2020 [accessed on November 22,2022] https://www.nippon.com/en/news/yjj2020121400645/japan-to-suspend-go-to-travel-program-entirely.html
2. Shi P, Dong Y, Yan H, Zhao C, Li X, Liu W, He M, Tang S, Xi S. Impact of temperature on the dynamics of the COVID-19 outbreak in China. Sci. Total Environ. 2020;728:138890.
3. Tobias A, Molina T. Is temperature reducing the transmission of COVID-19? Environ. Res. 2020;186:109553.
4. Yao Y, Pan J, Liu Z, Meng X, Wang W, Kan H, Wang W. No association of COVID-19 transmission with temperature or UV radiation in Chinese cities. Eur. Respir. J. 2020;55:2000517.
5. Walrand S. Autumn COVID-19 surge dates in Europe correlated to latitudes, not to temperature–humidity, pointing to vitamin D as contributing factor. Scientific Reports. 2021;11(1981) https://www.nature.com/articles/s41598-021-81419-w
6. Kurita J, Sugawara T, Ohkusa Y. Mobility data can reveal the entire COVID1-19 outbreak course in Japan. MEDRXIV/2020/081315 https://www.medrxiv.org/content/10.1101/2020.04.26.20081315v3
7. Bergman N, Fishman R. Mobility Reduction and Covid-19 Transmission Rates.

https://doi.org/10.1101/2020.05.06.20093039

8. Flaxman S, Mishra S, Gandy A, Unwin HJT, Mellan TA, Coupland H, Whittaker C, Zhu H, Berah T, Eaton JW, Monod M, Imperial College COVID-19 Response Team; Ghani AC, Donnelly CA, Riley S, Vollmer MAC, Ferguson NM, Okell LC, Bhatt S. Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. Nature. 2020;584(7820):257–261. doi: 10.1038/s41586-020-2405-7.
9. Li Y, Campbell H, Kulkarni D, Harpur A, Nundy M, Wang X, Nair H, for the Usher Network for COVID-19 Evidence Reviews (UNCOVER) group. The temporal association of introducing and lifting non-pharmaceutical interventions with the time-varying reproduction number (R) of SARS-CoV-2: a modelling study across 131 countries. Lancet Infect. Dis. 2021;21:193–202**.** DOI:https://doi.org/10.1016/S1473-3099(20)30785-4?
10. Larrosa JMC. SARS-CoV-2 in Argentina: Lockdown, mobility, and contagion. J. Med. Virol. 2020. doi: 10.1002/jmv.26659. https://onlinelibrary.wiley.com/doi/10.1002/jmv.26659
11. Japan Ministry of Health, Labour and Welfare. Countermeasure for variant strain of COVID-19 reported at the 32nd Advisory board for infection control to COVID-19. https://www.mhlw.go.jp/content/10900000/000774322.pdf (in Japanese) [accessed on May 19, 2021]
12. Leung K, Shum MHH, Leung GM, Lam TTY, Wu JT. Early transmissibility assessment of the N501Y mutant strains of SARS-CoV-2 in the United Kingdom, October to November 2020.

Euro. Surveill. 2021;26:2002106. doi: 10.2807/1560-7917.ES.2020.26.1.2002106.

13. Graham MS, Sudre CH, May A, Antonelli M, Murray B, Varsavsky T, Klaser K, Canas LS, Molteni E, Modat M, Drew DA, Nguyen LH, Polidori L, Selvachandran S, Hu C, Capdevila J; COVID-19 Genomics UK (COG-UK) Consortium, Hammers A, Chan AT, Wolf J, Spector TD, Steves CJ, Ourselin S. Changes in symptomatology, reinfection, and transmissibility associated with the SARS-CoV-2 variant B.1.1.7: an ecological study. Lancet Public Health. 2021;6:e335–e345.
14. Davies NG, Abbott S, Barnard RC, Jarvis CI, Kucharski AJ, Munday JD, Pearson CAB, Russell TW, Tully DC, Washburne AD, Wenseleers T, Gimma A, Waites W, Wong KLM, van Zandvoort K, Silverman JD; CMMID COVID-19 Working Group; COVID-19 Genomics UK (COG-UK) Consortium, Diaz-Ordaz K, Keogh R, Eggo RM, Funk S, Jit M, Atkins KE, Edmunds WJ. Estimated transmissibility and impact of SARS-CoV-2 lineage B.1.1.7 in England. Science. 2021;372(6538):eabg3055. doi: 10.1126/science.abg3055.
15. Zhao S, Lou J, Cao L, Zheng H, Chong MKC, Chen Z, Chan RWY, Zee BCY, Chan PKS, Wang MH. Quantifying the transmission advantage associated with N501Y substitution of SARS-CoV-2 in the UK: an early data-driven analysis. J. Travel Med. 2021;28:taab011.
16. Kagoshima prefecture office. Outbreak situation in Kagoshima prefecture https://www.pref.kagoshima.jp/kenko-fukushi/covid19/hassei/index.html#hassei (in Japanese) [accessed on May 1, 2021].

17. Kurita J, Sugawara T, Ohkusa Y. Estimating Event Ban Effects on COVID-19 Outbreak in Japan. Journal of Health Science and Development. 2021;4: https://www.innovationinfo.org/articles/JHSD/JHSD-137.pdf

18. Kurita J, Sugawara T, Ohkusa Y. Effects of climate conditions, mobility trends, and countermeasures on the COVID-19 outbreak in Japan https://www.medrxiv.org/content/10.1101/2020.12.29.20248977v1?versioned=true

19. Kurita J, Sugawara T, Ohkusa Y. Estimating event ban effects on COVID-19 outbreak in Japan https://www.medrxiv.org/content/10.1101/2020.12.29.20248977v6

20. Anzai A, Nishiura H. "Go To Travel" Campaign and Travel-Associated Coronavirus Disease 2019 Cases: A Descriptive Analysis, July–August 2020. J. Clin. Med. 2021; 10:398. https://doi.org/10.3390/jcm10030398

21. Kimball A, Hatfield KM, Arons M, James A, Taylor J, Spicer K, Bardossy AC, Oakley LP, Tanwar S, Chisty Z, Bell JM, Methner M, Harney J, Jacobs JR, Carlson CM, McLaughlin HP, Stone N, Clark S, Brostrom-Smith C, Page LC, Kay M, Lewis J, Russell D, Hiatt B, Gant J, Duchin JS, Clark TA, Honein MA, Reddy SC, Jernigan JA; Public Health? Seattle & King County; CDC COVID-19 Investigation Team. Asymptomatic and Presymptomatic SARS-CoV-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility – King County, Washington, March 2020. Morb. Mortal. Wkly. Rep. 2020;69:377–381.

22. Kagoshima City Tourism Association, Statistics on Tourism, https://www.city.kagoshima.lg.jp/kan-senryaku/miraisenryaku/documents/r3kankoutoukei.pdf (in Japanese) [accessed on November 11, 2022]

23. European Centre for Disease Prevention and Control. Epidemiological update: SARS-CoV-2 Omicron sub-lineages BA.4 and BA.5. https://www.ecdc.europa.eu/en/news-events/epidemiological-update-sars-cov-2-omicron-sub-lineages-ba4-and-ba5 [accessed on August 22, 2022]

23 National Institute of Infectious Diseases. Updated Situation of COVID-19 Outbreak (July 13,2022) https://www.niid.go.jp/niid/ja/2019-ncov/11309-covid19-ab90th.html (in Japanese) [accessed on August 20, 2022]

24 Graham MS, Sudre CH, May A, Antonelli M, Murray B, Varsavsky T, Klaser K, Canas LS, Molteni E, Modat M, Drew DA, Nguyen LH, Polidori L, Selvachandran S, Hu C, Capdevila J; COVID-19 Genomics UK (COG-UK) Consortium, Hammers A, Chan AT, Wolf J, Spector TD, Steves CJ, Ourselin S. Changes in symptomatology, reinfection, and transmissibility associated with the SARS-CoV-2 variant B.1.1.7: an ecological study. Lancet Public Health. 2021;6:e335–e345.

25 Davies NG, Abbott S, Barnard RC, Jarvis CI, Kucharski AJ, Munday JD, Pearson CAB, Russell TW, Tully DC, Washburne AD, Wenseleers T, Gimma A, Waites W, Wong KLM, van Zandvoort K, Silverman JD; CMMID COVID-19 Working Group; COVID-19 Genomics UK

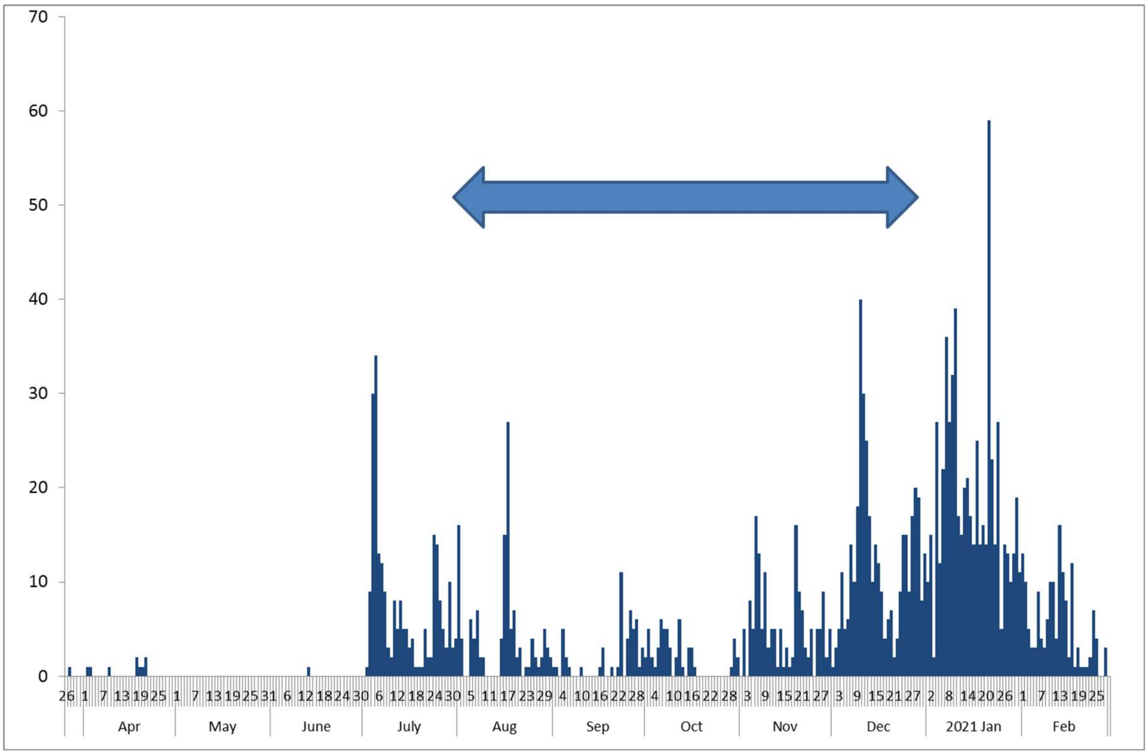
(COG-UK) Consortium, Diaz-Ordaz K, Keogh R, Eggo RM, Funk S, Jit M, Atkins KE, Edmunds WJ. Estimated transmissibility and impact of SARS-CoV-2 lineage B.1.1.7 in England. Science. 2021;372:eabg3055.

Table 1: Estimation results using data from June 20, 2020 until February 2021

| Explanatory variables | Estimated coefficients | *p*-value |
|---|---|---|
| Airport limousine bus users | -0.0028823 | 0.016 |
| Temperature | 0.0127021 | 0.763 |
| Humidity | 0.0030369 | 0.892 |
| Place: Restaurant, shopping mall or amusement | 0.0942825 | 0.032 |
| Place: Grocery store or pharmacy | -0.095054 | 0.034 |
| Place: Park | -0.0379907 | 0.084 |
| Place: Transition | 0.0276428 | 0.522 |
| Place: Workplace | -0.0351809 | 0.437 |
| Place: Home | -0.3026555 | 0.091 |
| 1st State of emergency | | |
| 2nd State of emergency | -3.774224 | 0 |
| GTTC | -3.040294 | 0 |
| Constant | 7.645734 | 0 |
| Number of observations | 273 | |
| Adjusted $R^2$ | 0. 2772 | |

Note: Yellow markers indicate significance except for constant terms.

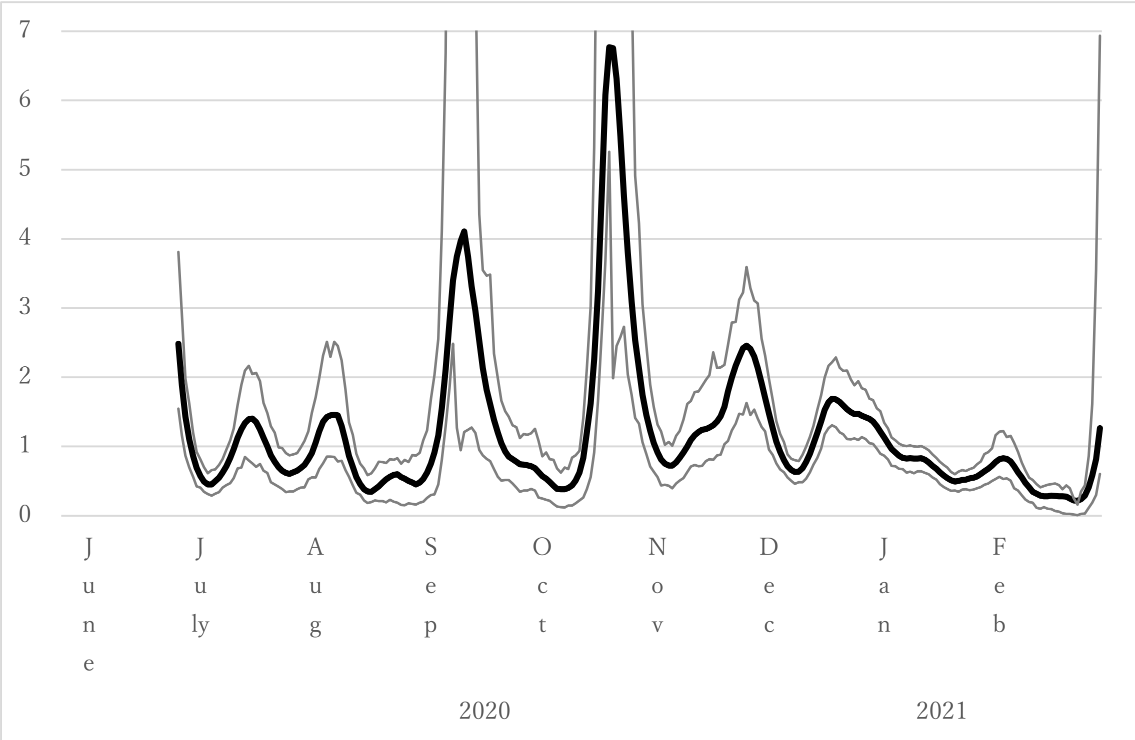
Figure 1: Number of newly confirmed COVID-19 patients in Kagoshima prefecture.




Note: Bars represent the epidemic curve showing the numbers of patients by onset date. Arrows indicate the period during which GTTC operated.

Figure 2: Map showing Kagoshima prefecture.

Figure 3: Effective reproduction number in Kagoshima and its 95% confidence interval from June 20, 2020 to the end of February, 2021.




Note: The black line represents the estimated effective reproduction number in Kagoshima prefecture. Two gray lines show upper and lower bounds of the 95% confidence interval.

Figure 4: Number of airport limousine bus users.