Response to COVID-19 in South Korea and implications for UK exit strategies

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Summary

- While South Korea experienced a sharp growth in COVID-19 cases early in the global pandemic, it has since rapidly reduced rates of infection.
- South Korea now maintains low numbers of daily new cases despite using less stringent “lockdown” measures than other affected countries.
- We find that rapid increases in both testing and transmission after identification of the Shincheonji cluster drove the sharp spike in cases with a genuine increase in R.
- Suspected and confirmed cases were therefore isolated quickly even during a short period of rapid expansion of the epidemic.
- South Korea managed to avoid a large COVID-19 epidemic by rapidly scaling up testing and therefore maintaining case-based interventions.
- Individual case-based contact tracing is a relatively minor aspect of their control program, with cluster investigations accounting for a far higher proportion of their cases.
    - The underlying epidemic was driven by a series of linked clusters, with 49% of all cases in the Shincheonji cluster and 19% in other clusters. Case-based contacts currently account for only 12% of cases.
- Some caution is needed in attempting to duplicate the South Korean response.
    - The high volume of testing and low number of deaths suggests that the total number of infections in South Korea is far lower than in the UK
    - Finding, testing and isolating cases that are linked to clusters may be more difficult during May or June in the UK than it was during March in South Korea, given UK case numbers will likely be 10-100 times larger.

South Korea reported their first case of COVID-19 on January 20th 2020, detected at Incheon international airport [1]. Sporadic cases with travel histories to mainland China were reported up to February 20th after which suspected cases with no travel history were tested prompted by identification of the Shincheonji cluster of local transmission in Daegu [2]. Incidence peaked on February 29th, shortly after Daegu was placed in a two-week quarantine [3] (Figure 1A). Daily incidence has since been declining, starting approximately three weeks before stricter social distancing measures, including stay at home recommendations and restriction of non-essential retail, were implemented nationally [4]. As of May 2nd, South Korea has reported a total of 10,780 cases with only 6 new cases in the last day and notably no new domestic cases on 29th April. The pattern of COVID-19 deaths in South Korea has not followed the same clear epidemic pattern as cases (Figure 1B), with a total of 250 deaths as up to and including May 1st, distributed throughout the period since February 20th with a peak of only 11 deaths per day.

Transmission

Estimates of SARS-CoV-2 transmissibility in South Korea vary substantially over time (Figure 2). We estimated the time-varying reproduction number, R, based upon previously published methods [5]. Using a 7-day sliding window and confirmed case data by date of report, we estimated that R initially dropped below 1 likely due to strong surveillance measures stemming imported cases from China [6]. Estimates of R increased significantly after the identification of the large Shincheonji cluster and changes in testing protocol on 18th and 20th of February, respectively [7,8]. We estimated a very high R of 25 following this significant increase in testing and local transmission. However, this estimate is biased upwards as our method assumes constant reporting and we cannot disentangle the contributions of increased testing and increased transmission on R. Estimates are likely stable by the beginning of March, however, and even with high and stable levels of testing at this point (Figure 3), R was still above 3. However, it dropped to a low of 0.4 before rebounding back to 1 at the start of April. During April, it has continued to fall, even at low incidence, to current estimates of ~0.5.

Social distancing

Unlike other countries affected by COVID-19, South Korea has not implemented a national “lockdown”, however, a localised lockdown of Daegu occurred after the discovery of the large cluster of cases associated with Shincheonji religious group [9]. Movement in Daegu decreased by 80% during this period as compared to the same time in 2019, and decreased nationally by 38.1% during February 24th - March 1st as compared to January 9th - 22nd before the first case had been detected in South Korea [10,11]. On March 22nd in response to the ongoing emergence of local small clusters, imported cases, and an increase in population movement up to 28% below baseline [10], the Korean Government implemented a stronger social distancing campaign nationally (Figure 1A). People were asked to only leave their houses for daily necessities, healthcare and commuting to work, and many community spaces were asked to close [12]. On April 19th low contact outdoor facilities and churches were allowed to reopen. From May 5th South Korea is scheduled to step-down to long term routine distancing with exact details to be decided and released by individual departments [13]. The move to routine distancing depends on low daily case numbers, very low incidences of detecting apparently sporadic cases and >80% of new cases being

detected in individuals who are already in self-quarantine, which is currently being met [14]. Social distancing measures will then be re-evaluated every two weeks [12].

Testing

By licensing private companies and clinics to conduct tests early in the epidemic South Korea rapidly expanded testing capacity from 3000/day on February 7th [4] to 15,000 - 20,000/day with a turnaround time of 6 – 24 hours by the end of March (Figure 3). As of 25th March, there were 118 institutions capable of conducting tests for COVID-19 including: KCDC, 4 National Quarantine Stations, 18 Research Institutes of Public Health and Environment (RIPHEs), and 95 private medical laboratories and hospitals [2]. Initially, only individuals who were symptomatic and had a history of travelling in areas with known infections or had been in contact with confirmed cases were tested [15]. However, testing policy changed on February 20th to test anyone exhibiting symptoms, regardless of travel history, and to all close contacts of confirmed cases [16]. This coincided with the Shincheonji cluster and explosive growth in cases, therefore bringing the average number of tests conducted per case down after this date. As case numbers have since decreased, the average tests per case has increased again (Figure 4). The estimated mean delay from exposure to infection confirmation was 7.2 days (95% CI 1.7-14.4 days) in the early phase of the outbreak and 6.5 days (95% CI 1.7-15.7 days) from February 23rd onwards [17]. For the first 28 patients, the estimated mean delay from symptom onset to diagnosis was 5.2 days (range: 0-16 days) [18]. Data are not available for later periods, but from the exposure to confirmation delay, one can infer that most cases must be tested within 2 days of symptom onset.

Clusters and contact tracing

A high proportion of cases have been linked to other cases in South Korea throughout their outbreak. Case-based contact tracing in South Korea can be separated into linking to clusters and identification of individual contacts (Figure 5A), where clusters now account for 68% of South Korea's COVID-19 cumulative cases nationally, while individual case-based contacts account for only 12%. The large cluster associated with the Shincheonji religious group, accounts for 49% of all cases nationally. Although most cases were in Daegu, the cluster extended to group members in Gyeongbuk, Gyeongnam, Ganwon, Ulsan and Gwangju provinces. Other smaller clusters mainly in workplaces, hospitals and churches, make up the further 19% of cases (ranging in size from 2-196 people). Between March 25th and April 28th, the Shincheonji cluster contributed very few new cases, and the percentage of new cases that were imported increased to ~60% (Figure 5B).

Isolation

Isolation of cases and self-quarantine of contacts has been a consistent feature of the South Korean response. As of April 28th, there were 1,654 confirmed cases currently isolated (Figure 6). We did not identify openly accessible data sources that reported the number of contacts isolated over the course of the outbreak, although media outlets reported that there were around 30,000 people in self-quarantine on March 6th [19], 27,000 on April 2nd [20] and 46,000 on April 7th [21]. Based on severity and risk factors, confirmed cases are either isolated in hospital (1 room per patient or attempted cohort isolation), at home or in a Residential Treatment Centre (RTC). Cases are isolated in RTCs when symptoms are too severe for home isolation, but do not require hospitalisation; or when home isolation is not

possible because no individual room is available or they live with a high-risk person [22]. Medical staff in RTCs and public health managers (for home isolation) monitor and record patient's symptoms twice per day and, if necessary, transfer them to medical facilities. Close contacts of confirmed cases are asked to self-quarantine for 14 days and are monitored every day.

The estimated mean delay from symptom onset to isolation of cases was 4.3 days (95% CI 0.5-11.3 days), and 3.3 days (95% CI: 0.5-9.4 days) before and after the red alert warning on February 23rd respectively [23]. Confirmed cases must test negative twice in 24 hours before they can be released from isolation [22]. Close contacts with no symptoms in the 14 days following contact can be released from home quarantine after testing negative at the end of the quarantine period.

Conclusions

South Korea has managed to avoid a large COVID-19 epidemic by rapidly scaling up testing and therefore the ability to maintain case-based interventions. Individual case-based contact tracing is a relatively minor aspect of their control program, with cluster investigations accounting for two-thirds of cases identified. Some caution is advised in attempting to duplicate their response because the high volume of testing and low number of deaths suggests that the total number of infections in South Korea has been far lower than in the UK.

Figures

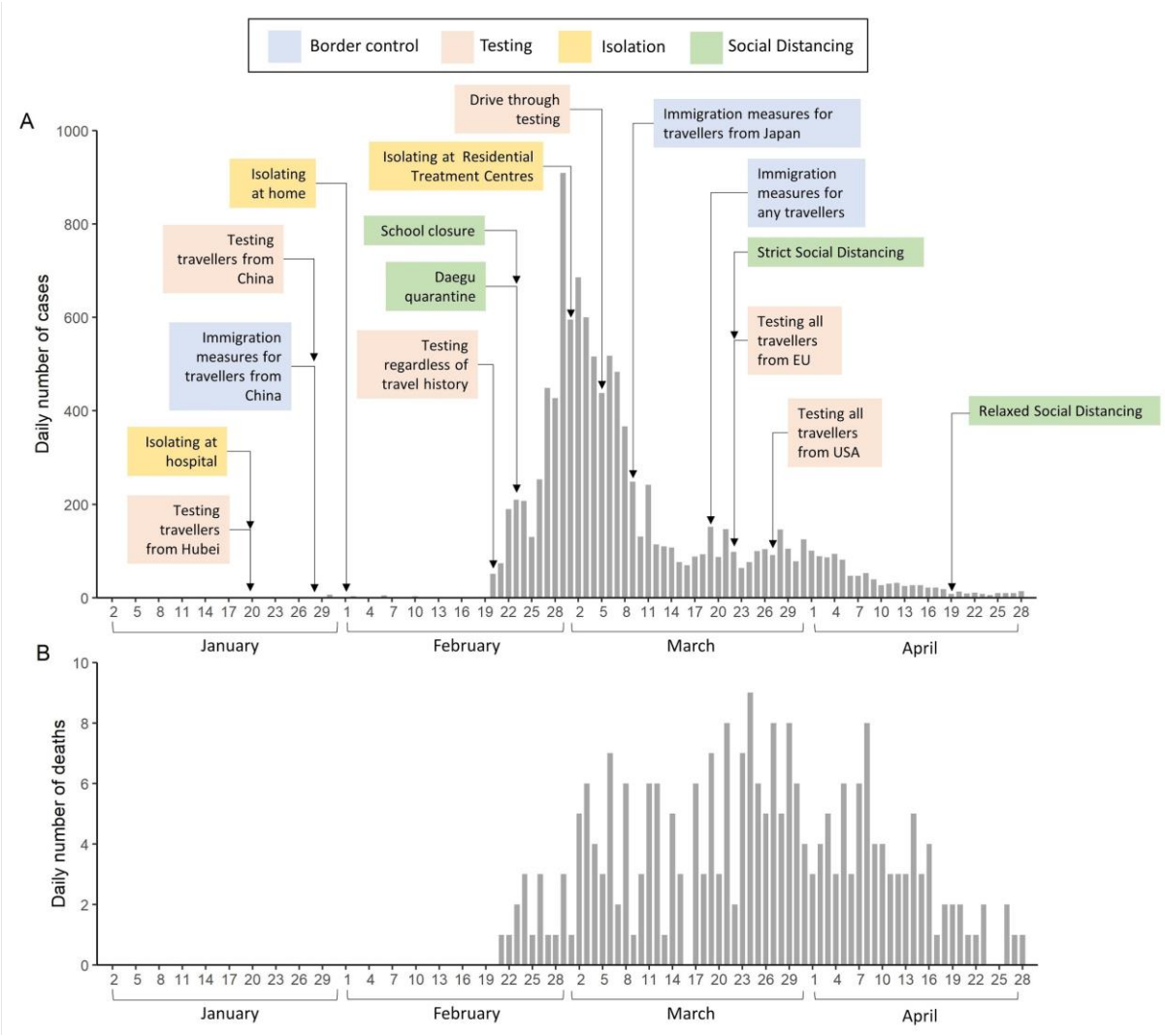

Figure 1. Incidence of confirmed cases with key intervention timings (A), and deaths (B).

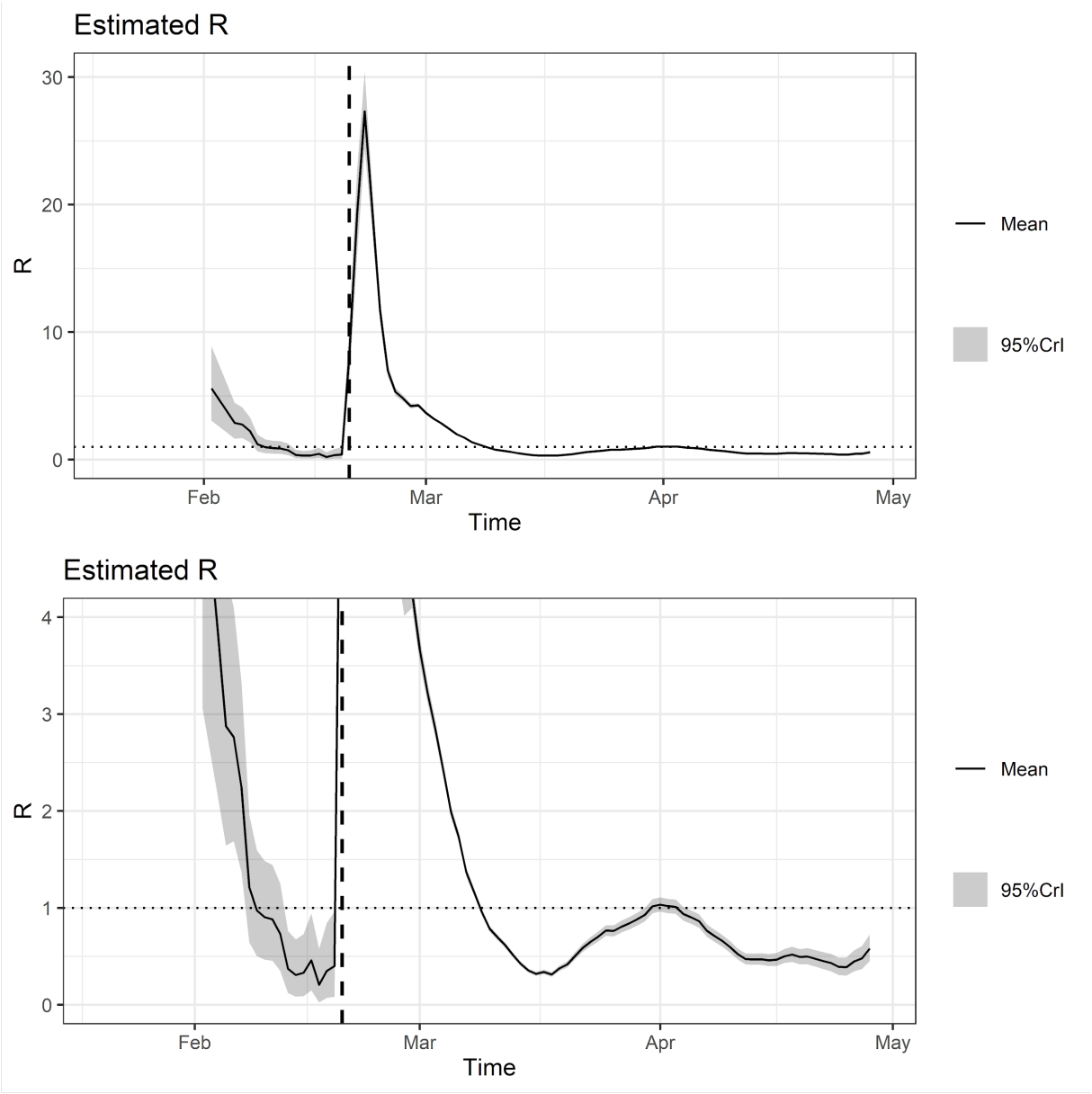

Figure 2. Estimates of effective reproductive number R based on confirmed cases by date of report. R is estimated using a sliding window of 7 days and an uninformative prior with mean 1 and standard deviation 10. The black line represents the posterior median value of R and the shaded region shows the 95% credible interval. The dotted horizontal line shows R = 1. The top panel shows the full range of R values, with the bottom panel zoomed in to R between 0 and 4. Vertical dotted line indicates the time at which the testing protocol was changed.

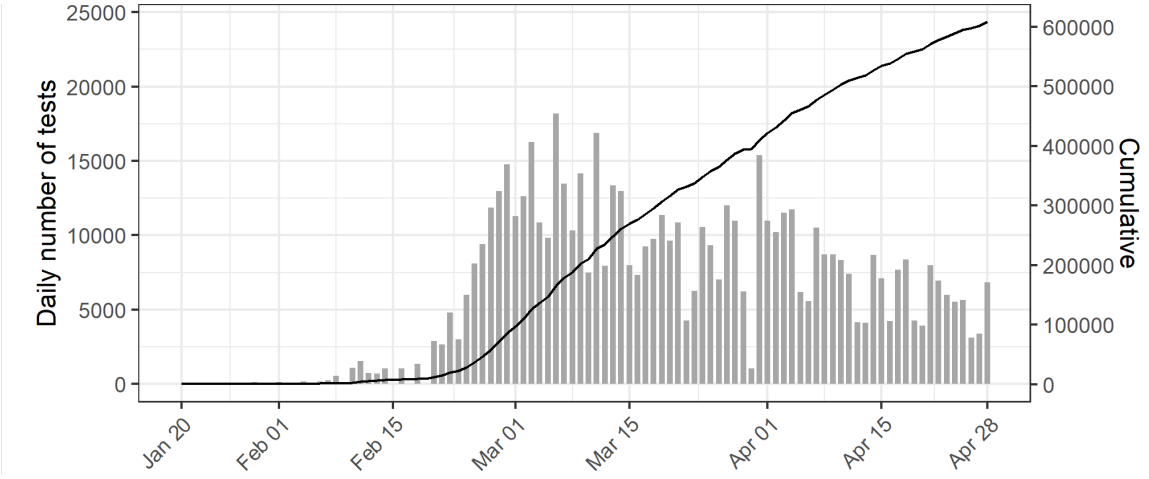

Figure 3. New and cumulative numbers of people being tested in South Korea from the beginning of the COVID-19 outbreak on January 20th until April 28th 2020. Grey bars represent daily incidence by date of report and black lines cumulative numbers.

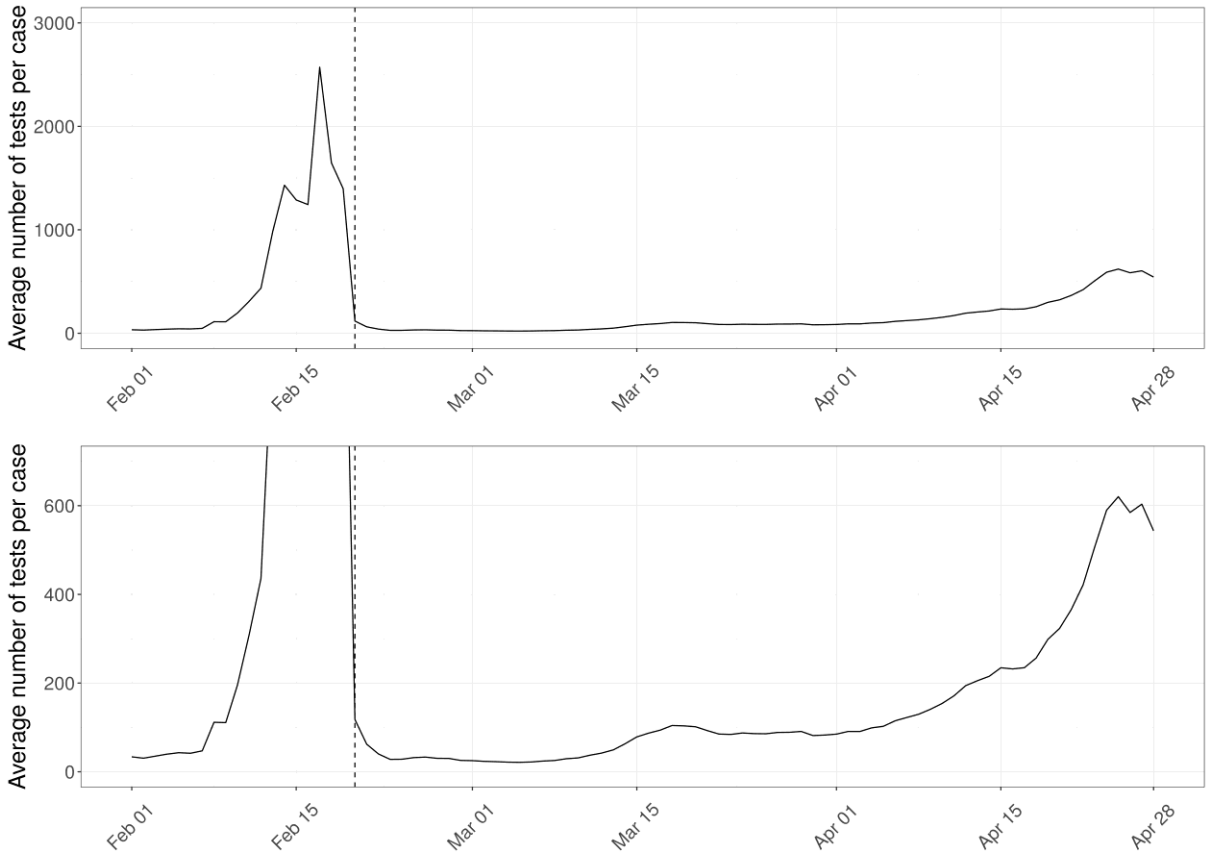

Figure 4. Rolling 7-day average of the number of people tested per case until April 28th, 2020. The dashed vertical line indicates the date on which South Korea changed its testing protocol from testing suspected cases with contact with a case or travel history to a country with infections to testing all suspected cases (February 20th). Bottom panel zooms in to show region of 0 – 600 tests per case. Source: KCDC press releases.

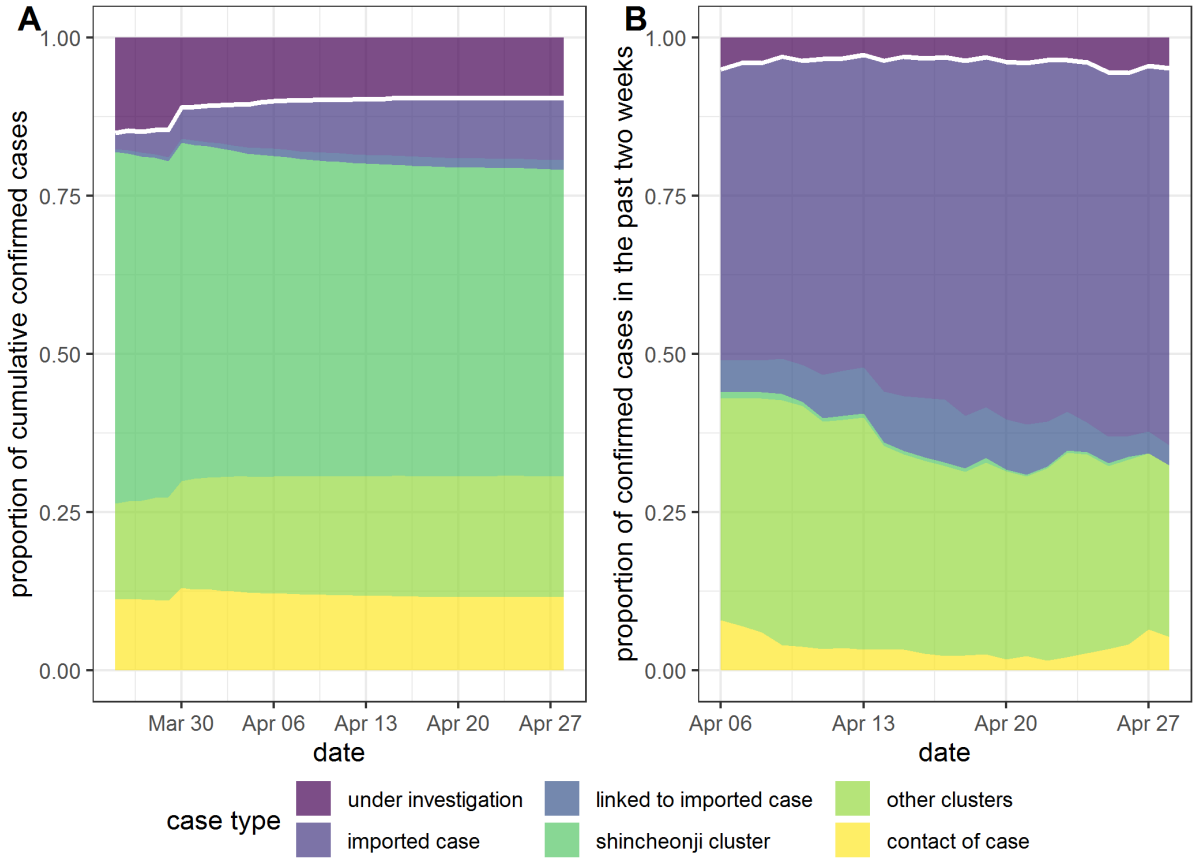

Figure 5. A. Cumulative proportion of cases by type from March 25th to April 28th. The proportion of cumulative confirmed cases that are linked to existing cases or imported (white line) as opposed to “under investigation” (which includes apparent sporadic cases). Linked cases are broken down into whether they are connected to an imported case, part of the Shincheonji cluster, a smaller cluster or a contact of a confirmed case. **B.** Proportion of new cases by type of contact during April.

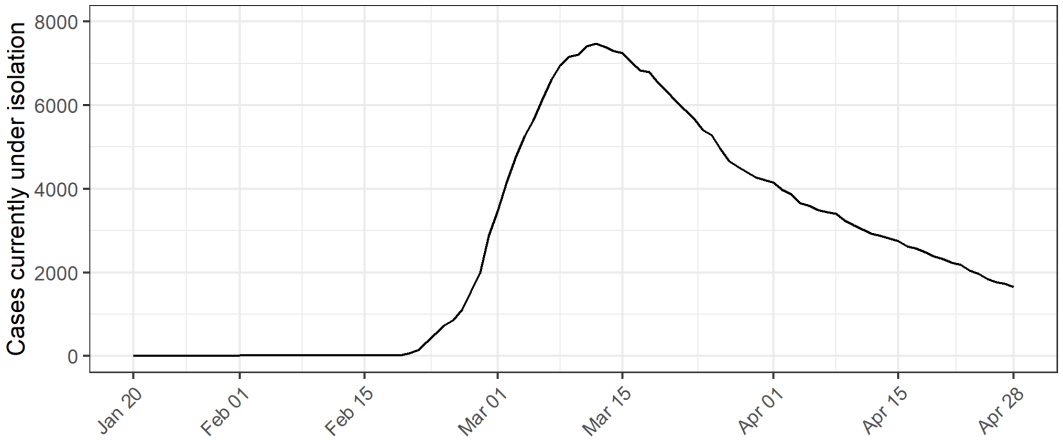

Figure 6. Isolation dynamics in South Korea. Prevalence of confirmed cases currently in isolation.

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