

Rapid Communication

How we should respond to the Coronavirus SARS-CoV-2 outbreak: A German perspective

F. Jung^a, V. Krieger^b, F.T. Hufert^{c,d,*} and J.-H. Küpper^{a,d}

^a*Institute of Biotechnology, Molecular Cell Biology, Brandenburg University of Technology, Senftenberg, Germany*

^b*TMM AG Böblingen, Department Head Lab Planning and Norming of Information Management, Böblingen, Germany*

^c*Institute for Microbiology and Virology, Brandenburg Medical School, Senftenberg, Germany*

^d*Faculty of Health Sciences, Joint Faculty of the Brandenburg University of Technology Cottbus – Senftenberg, the Brandenburg Medical School Theodor Fontane and the University of Potsdam, Senftenberg, Germany*

Abstract.

Background: In the early phase of the COVID-19 pandemic Germany missed to set up efficient containment measures. Consequently, the number of cases increased exponentially until a lockdown was implemented to suppress the spread of SARS-CoV-2. Fortunately, Germany has a high capability for coronavirus lab testing and more than 30,000 ICU beds. These capabilities and the lockdown turned out to be an advantage to combat the pandemic and to prevent a health-system overload.

Aim: The aim was to predict the plateau day of SARS-CoV-2 infections or deaths.

Results: The effect on the viral spread of the German measures taken and the impact on the peak of new infection cases is shown. By normalizing daily case numbers, the plateau day of the current outbreak in Germany could be calculated to be reached at April 12, 2020 (day 103 of 2020).

Conclusion: Normalized case number curves are helpful to predict the time point at which no further new infections will occur. Upon reaching the plateau day during a lockdown phase, a residual time-period of about 2-3 weeks can be utilized to prepare a safe unlocking period. As can be learned from Asian countries such as South Korea and Taiwan there must be strict rules to keep the risk of infection low. Those include social distancing, face mask wearing in combination with digital contact tracing and serosurveillance studies. Following those rules, a safe dance around the infection curve allows to keep the population at a reduced infection rate.

Keywords: Corona virus, SARS-CoV-2, COVID-19, herd immunity, hammer and dance strategy

1. Outbreak chronology and counter measures with a focus on Germany

In December 2019, a novel coronavirus emerged in the metropolis of Wuhan, China, causing a severe lung disease. On December 31, China informed the WHO of a total of 27 patients with pneumonia, and already on January 7, 2020, Chinese scientists succeeded in identifying the infectious agent. The new

*Corresponding author: Frank T. Hufert, E-mail: frank.hufert@mhb-fontane.de.

32 coronavirus SARS-CoV-2 is highly related to the well-known bat-borne SARS-CoV which emerged in
33 February 2003 [1, 2] and to the Middle East respiratory syndrome coronavirus (MERS-CoV) detected
34 in 2015 [3]. The 2003 global SARS outbreak spread to more than two dozen countries in North America,
35 South America, Europe, and Asia before it was contained. More than 8,000 cases with a mortality of
36 10–50% depending on age occurred globally [4, 5]. On January 11, 2020, China reported the first death
37 from the new disease COVID-19. China reacted with severe counter measures including quarantine and
38 complete highly controlled lockdown of the affected areas. In the following week first cases outside
39 of China were reported from Thailand and Japan which were imported from Wuhan and first evidence
40 of human to human transmission was reported. On January 21, the first imported case appeared in the
41 USA and on January 24, SARS-CoV-2 emerged globally in many other countries including Europe
42 where first were reported from France [6–8]. On January 26, China reported 2000 confirmed cases and
43 56 COVID-19 deaths and measures to contain the spread were strengthened. Already on January 23,
44 the Chinese government ordered the complete lockdown of social and economic life in Wuhan city,
45 later followed by nationwide closure of schools and universities. On January 27, the infection was
46 detected in Germany for the first time. An employee of the Bavarian company Webasto was infected
47 by a Chinese visitor to the company who later tested positive for SARS-CoV-2 after her return home
48 to China and was apparently almost symptom-free in Germany.

49 On January 30, the WHO declared the status of health emergency because of COVID-19. However,
50 the federal authority for infectious diseases in Germany, Robert Koch Institute (RKI), still defined the
51 risk for Germany as being low and did not recommend to close borders and stop incoming flights to
52 Germany. The experts believed that all emerging SARS-CoV-2 cases were under control and contact
53 persons quarantined.

54 However, from that time point on the outbreak within Germany increased rapidly because dozens
55 of SARS-CoV-2 infected people returned from Ski vacation in Tyrol and from Italy. Failure to impose
56 an early ban on entry into the country from the risk areas in Austria, Italy and China was a serious
57 mistake, particularly when the strategy to combat the outbreaks is based on eradication. Besides that,
58 in Germany the federal structures of the public health service hampered a straight-forward approach
59 to fight the pandemic.

60 Despite the fact that there was strong evidence of rapid person-to-person transmission [9] even
61 before classical clinical symptoms of a respiratory disease were present [10] carnival meetings were
62 held in different regions such as in the district of Heinsberg and other cities in the West and Southwest
63 of Germany pouring oil into the fire of the outbreak. As a result, on March 10, over 300 people in the
64 Heinsberg district tested positive for SARS-CoV-2.

65 On March 17, the RKI classified the risk situation for Germany as moderate to high. Until this point,
66 there were already more than 9,000 confirmed SARS-CoV-2 cases and 26 COVID-19-related deaths
67 in Germany. The German public learned about the strategy of herd immunity meaning that at least
68 60% of the population will be infected to create a protective barrier. At this stage, there was no reliable
69 information on COVID-19 mortality. The WHO calculated the case fatality rate to be 3-4 %, with the
70 true infection fatality rate to be much lower (WHO Situation Report 46 as of March 6, 2020). Assuming
71 an infection fatality rate of 0.5 % for SARS-CoV-2, herd immunity of the German population would
72 generate about 250,000 deaths – by COVID-19 only. In addition, there would have been further deaths
73 due to massive overload of the German health system.

74 On March 18, German Chancellor Angela Merkel for the first time addressed the population directly
75 in a speech on the coronavirus outbreak. She described the situation as follows: “It is serious. Take it
76 seriously, too!” Since World War II, there has been no challenge to the country where national solidarity
77 was so important as right now, she said.

78 On March 22, following a consultation with the federal state’s Prime Ministers, the German Chan-
79 cellor tightened up the measures and announced a total of nine rules of conduct for Germany to be

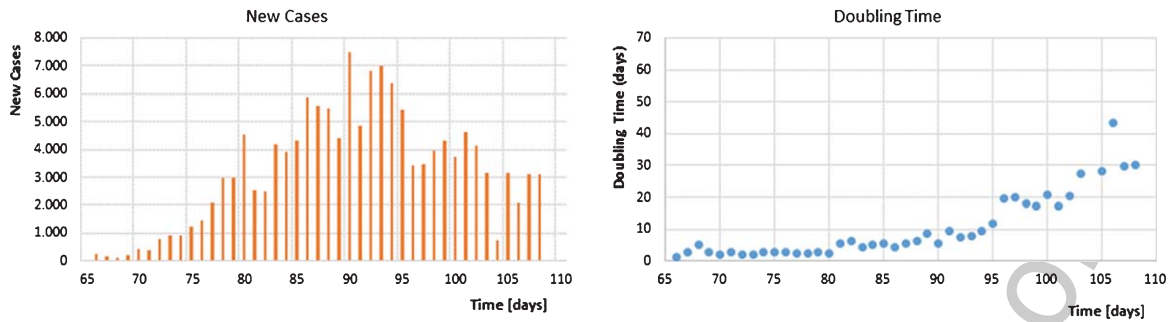


Fig. 1. New cases and doubling time during SARS-CoV-2 outbreak in Germany until day 105 beginning at the 1st of January.

valid from midnight on Monday, March 23. The central point was “to reduce public life as far as it is justifiable”. This included limiting contacts to persons other than those living in the same household to the bare minimum, keeping a minimum distance of at least 1.5 m in public, only two persons not living in the same household are allowed to meet, people are still allowed to go to work, to the doctor, to shop, to do outdoor sports alone, but parties in groups or meetings in parks were not allowed any longer. Service and catering establishments as well as restaurants were closed. These guidelines were initially valid for two weeks. Universities, schools, and kindergartens were already closed on March 16.

2. Results

2.1. Efficiency of the lockdown in Germany

Until the first day of lockdown in Germany on March 23 (day 83; day zero: 01/01/2020), about 29,000 people were already infected. Until April 12 (day 103), 127,459 cases and 2996 deaths due to COVID-19 were identified in Germany.

Figure 1 shows that until March 20 (day 80), the daily cases of new confirmed infections increased with doubling times between 1–5 days, showing a strong exponential rise of positive tests for SARS-CoV-2 infections in Germany. However, it is unlikely that the obvious decline of the curve after day 80 already reflects official counter measures of the German government. There is a delay of at least 10 days between an infection event and the registration of a positive test due to the virus incubation time of at least 5 days, the test time and the time until the positive result is reported to the authorities. Cumulative cases reported until March 20 reflect infection events until March 10, i.e. at a time point when the German public was not officially warned about the COVID-19 risks. However, it is possible that the number of positive tests at day 80 was still limited by the overall capacity of PCR-based SARS-CoV-2 detection.

One week after the initial lockdown, on March 30 (day 90), the highest number of new cases per day was reported (Fig. 1). Thereafter, the number of new daily cases started to decline continuously.

Doubling times show a flat course over the first 90 days. Then they started to increase strongly by about day 100 (April 9, 2020). At this time point, the test capacity was almost doubled in Germany. Thus, the declining number of new cases of persons with COVID-19-like symptoms should not have been affected any longer by the PCR testing capacity. This result should thus reflect the counter measures of the German government, especially the lockdown since March 23, and the substantial discussions of experts and politicians in public media of Germany. Doubling times were then steadily increasing, reaching 30 days or more since day 106.

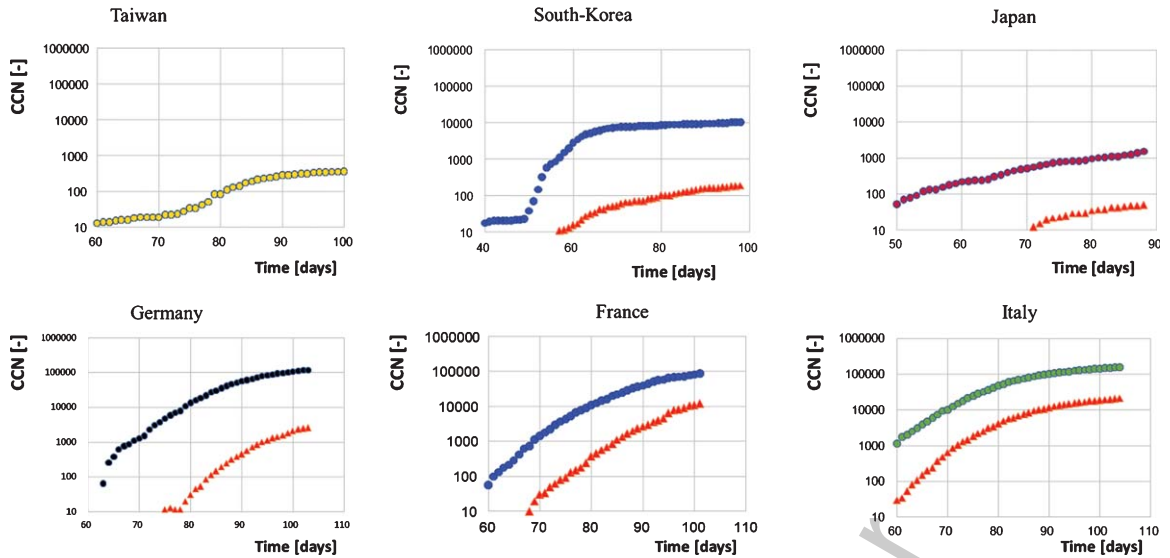


Fig. 2. Cumulative case numbers of infections (coloured dots) and deaths (red triangles) in East Asian and European States.

112 Figure 2 demonstrates the cumulative case numbers (CCN) of infections and deaths of the three
 113 European countries Germany, France and Italy, and the three East-Asian countries Taiwan, South
 114 Korea and Japan to document the different strategies followed during the COVID-19 crisis. It is
 115 obvious that in the East-Asian countries measurements were taken right at the beginning of the SARS-
 116 CoV-2 pandemic to contain the virus spread. Taiwan and South Korea used their knowledge from the
 117 first SARS pandemic in 2003 and the 2015 outbreak of MERS-CoV. In South Korea, where a religious
 118 community initiated a fatal infection cluster in the city of Daegu, schools were closed soon, infected
 119 persons were efficiently tracked with smartphone apps and rigorous testing for SARS-CoV-2 infections
 120 were performed [3, 11]. Taiwan used a combination of big data analytics, community protection and
 121 rigorous testing to combat the crisis. As being closely located to the mainland of China, Taiwan was at
 122 high risk for outbreak of COVID-19, but the country was able to implement fast and efficient counter
 123 measures [12, 13]. By the end of February 2020, the government of Japan recommended closing of
 124 schools, entry ban of people from coronavirus risk regions and a stop of sports and cultural events.
 125 These early reactions and the fact that the Japanese are used to wearing face masks during seasonal
 126 influenza [14] seemed to help combat the SARS-CoV-2 outbreak until end of March 2020. After
 127 a period of stagnation, cases in Japan were reported to increase again as people were reducing their
 128 social distancing in public. However, the total number of confirmed cases is still much lower than
 129 reported for European countries. Common elements of these Asian states were the immediate action
 130 of governments to implement certain social distancing strategies and the wearing of face masks in
 131 public to reduce the number of new cases, which has proven to be effective to prevent transmission
 132 from infected individuals [15].

133 By contrast, the three European states had some delay in their national responses to the SARS-CoV-2
 134 pandemic. At the starting points of the outbreak during the end of January 2020, there were neither
 135 discussions on travel entry bans nor recommendations on social distancing, and wearing of face masks
 136 in the public was also not recommended. This led to a longer phase of exponential growth of SARS-
 137 CoV-2 infections and deaths in Germany, France and Italy and caused cumulative case numbers to
 138 grow significantly higher in comparison to the East-Asian countries (Fig. 2).

139 The data were obtained from the following sources: Taiwan, South-Korea: and Japan: [www.ecdc.
 140 europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-world](http://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-world)

141 wide; Germany: https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Fallzahlen.html;
142 France: who.sprinklr.com/region/euro/country/fr, Italy: github.com/pcm-dpc/COVID-19).

143 The data obtained from the above listed sources is put in to a context described herein with. Our
144 policy regarding the information format is prioritizing Open Source and Free Software. We therefore
145 make all data retrieved and analyzed hereby available at corona.milliways.online.

146 2.2. Calculation of the plateau day to predict the behaviour over time of corona infections

147 Due to the imperative of social distancing and the lockdown decreed in European countries, the
148 increase in case numbers flattened out considerably. Figure 2 shows that for Germany the lockdown
149 could allow to keep the cumulative number of cases below 150-200 thousand. This clearly would
150 prevent the collapse of the health system in Germany.

151 This is best seen in logarithmic representation. The scope of this work is primarily to provide a
152 forecast for the time when theoretically there will be no more growth of confirmed cases. At that time
153 point the growth of values (e.g. corona cases confirmed) is zero - resulting also in zero slope of the
154 curves in Fig. 2. However, it is not possible to read from this cumulative diagram the exact point in time
155 when no more cases should occur, as the slope at the peak is getting flatter. To overcome this problem,
156 one can plot normalised growth rates (corona cases at day n – corona cases at day $n-1$) / corona cases
157 at day n) against a linear timeline. This normalization keeps each rate of change in the range between
158 0% and 100%.

159 By plotting these normalized change rates against the standardized day counts, an approximate
160 linear behaviour can be observed. The approximation lines meet the x-axis at the day when no further
161 infections or deaths will occur – provided that no systematic changes in the underlying social epidemic
162 behaviour occur in the following days. We call this day the “plateau day”. This type of analysis enables
163 health-policy makers to adjust in time to the point at which both new cases and deaths will end.

164 Figure 3 shows that Germany, France and Italy reached their calculated plateau days, i.e. the days
165 when no further confirmed SARS-CoV-2 cases should be found, at day 103, 107 and 101, respectively.
166 The respective plateau day of deaths is 7–14 days later for Germany and France, but only 3 days for
167 Italy.

168 It can be seen from the curves for Germany and Italy, that there were still new cases detected at the
169 time point of the plateau day, when the approximation line meets the x-axis. Of course, the infection
170 events that led to those newly confirmed cases occurred at least 10 days before and could reflect
171 variations in Western-oriented societies tending to behave individually rather than collectively.

172 In contrast, South Korea has achieved the fastest descent with only very few further cases detected at
173 the expected plateau date. The same course is to be expected from Taiwan. This points out that efficient
174 measures along with a high compliance of a population can lead very quickly to success. In the case
175 of Japan, it is different. This country always showed low numbers (see day rate), but there was also
176 a moderate rate of testing (less than 10,000 tests per day). Using the actions described above, Japan
177 fought their way down to zero on day 82, but then popular events such as the *Cherry Blossom Festival*
178 occurred, and people started to behave more careless. Subsequently, more action such as regional or
179 general lockdown, social distancing etc. is required for Japan to keep SARS-CoV-2 infections low.

180 The coefficient of determination (R^2) assesses the quality of fit of the chosen linear model and thus
181 its ability to predict an outcome.

182 Since the zero line is reached for Taiwan and also South Korea and hardly any new cases occur,
183 a prediction of the linear correlation is no longer possible. Regarding Japan, the fluctuations are too
184 large for successful model fitting (only 8% of the fluctuations are due to time). Thus, there are strong
185 other factors that must explain the 92% fluctuation in the “normalized rate of change per day”.

Table 1
SARS-CoV-2 statistics on representative Western and East Asian Countries

	$f(0)$	Estimated plateau day	Cases confirmed at estimated plateau day	Population 2020 by source	Cases confirmed per capita	Medium age
Taiwan (TW)	99,7	2020-04-08	337	23.816.775	0,0014%	42
South Korea (SK)	70	2020-03-10	7506	51.269.185	0,0146%	44
Japan (JP)				126.476.461		48
Germany (DE)	102,9	2020-04-11	117.658	83.783.942	0,1404%	46
France (FR)	106,1	2020-04-15	103.573	65.273.511	0,1587%	42
Italy (IT)	101,5	2020-04-10	146.665	60.461.826	0,2426%	47

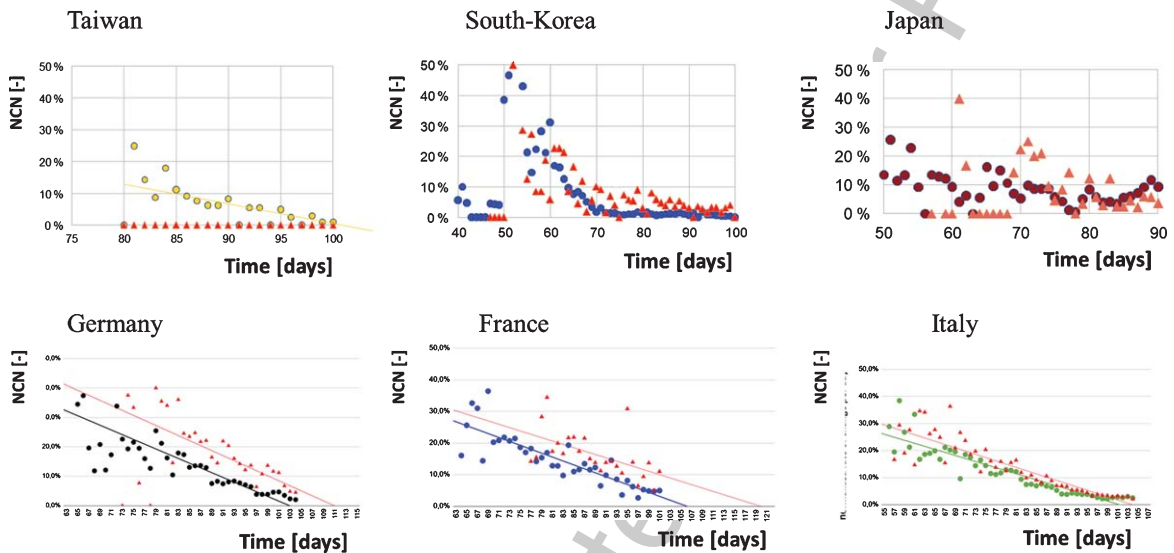


Fig. 3. Linear regression of normalised case numbers of infections (coloured dots) and deaths (red triangles) versus time in East Asian (Taiwan: $R^2 = 0.467$; South-Korea: $R^2 = 0.199$; Japan: $R^2 = 0.008$) and European States (Germany $R^2 = 0.556$; France: $R^2 = 0.073$; Italy: $R^2 = 0.836$).

186 However, the data show that outcome prediction by a simple linear model is possible for Italy, France
187 and Germany. A forecast can thus be made when no more cases will occur if social behaviour does
188 not change.

189 Table 1 shows times of plateau of corona infections ($f(0)$ in Table 1) and of deaths calculated
190 according to Fig. 3. In addition, the time delay between plateau of infections and deaths is shown. For
191 those countries, Table 1 provides the relevant data in relation to the cumulated cases, population sizes
192 and median age.

193 2.3. Consequences for Germany without decreed lockdown

194 Since March 23 (day 83) a strict lockdown was started in Germany. Public life was shut down
195 almost completely, schools, kindergartens and universities were closed. Many service providers such
196 as hairdressers and all restaurants were closed in Germany. Because of the lockdown, as many people
197 as possible worked from home. In contrast, not retarding the exponential virus spread in Germany

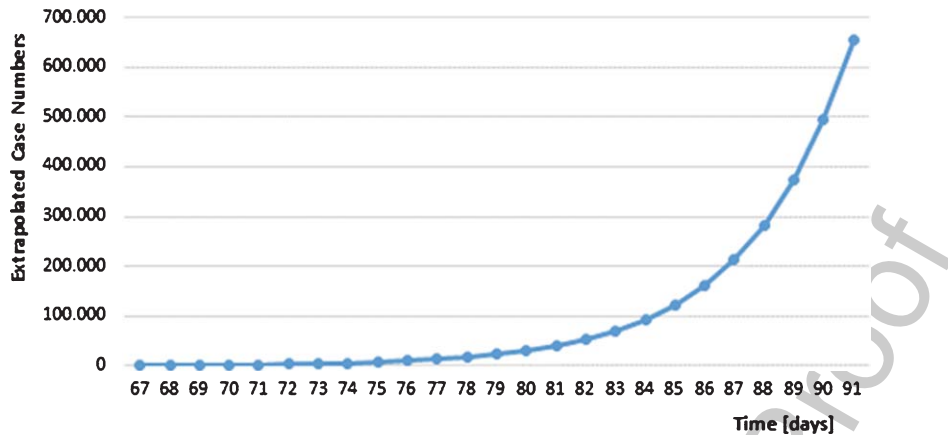


Fig. 4. Extrapolated case numbers without countermeasures in Germany. The extrapolation starts on day 67 with 797 confirmed cases and a median doubling time of 2.92 days.

198 characterized by short doubling times in the first weeks of March would have resulted in more than
 199 600,000 SARS-Cov-2 cases by the end of the month (Fig. 4). That clearly would have knocked out the
 200 German health system due to the limited capacity of 30,000 ICU beds, because about 5% of infected
 201 persons need intensive medical care according to RKI information. Thus mentioning the dramatic
 202 COVID-19 risks on March 18 by the German Chancellor Angela Merkel was one of the last chances
 203 to address the attention of the German population in order to slow down the SARS-CoV-2 spread
 204 preventing the breakdown of the German health care system.

205 2.4. How to successfully combat SARS-CoV-2 after lockdown: The Asian strategy versus herd 206 immunity

207 At the beginning of the SARS-CoV-2 outbreak, the strategy of herd immunity was pursued in
 208 Germany, the UK and in Sweden. The aim was simply to order measures that would flatten the curve
 209 in order to limit the number of people infected simultaneously to a level acceptable to the health care
 210 system. This strategy is also called mitigation. However, as mentioned above, this mitigation strategy
 211 would have caused at least 250 thousand deaths in Germany assuming 60% of the population to become
 212 infected based on a fatality rate of only 0.5%. This is not comparable to the death toll to be paid yearly
 213 for seasonal influenza, but rather to an armed conflict. A comparison with seasonal influenza outbreak
 214 is not possible, since the population is immune naïve to SARS-CoV-2 and the mortality is at least 5 to
 215 10 times higher compared to seasonal influenza. And even the influenza viruses have a high potential
 216 to cause severe outbreaks of public concern as documented in the 1918, seasonal influenza outbreaks
 217 after 1918 have never brought the German health care system to a collapse.

218 The alternative strategy to mitigation is called suppression. Germany as well as many other countries
 219 initiated this suppression phase with the decision to lock down. This is a decision that has probably saved
 220 hundreds of thousands of lives in Germany and other states. In the long run, however, the lockdown
 221 would entail serious economic and social costs. The lockdown can therefore only be temporary. In
 222 order to have a vision of a situation afterwards, it is helpful to compare the development of SARS-
 223 CoV-2 infections in Germany with that in Asian countries. Immediately the main difference of the
 224 development can be seen in March. The Asian countries South Korea, Japan and Taiwan had moderate
 225 increases in case numbers, far below the critical values for their respective health care systems.

226 While in Europe the epidemic was contained much too late, Taiwan shows how successful early
227 measures can be. Following the SARS experience of 2003, a National Health Command Centre (NHCC)
228 was established with the Central Epidemic Command Centre (CECC) as the central coordinating
229 body. The CECC has rapidly produced and implemented a list of at least 124 action items including
230 border control from the air and sea, case identification (using new data and technology), quarantine
231 of suspicious cases, proactive case finding, resource allocation (assessing and managing capacity),
232 reassurance and education of the public while fighting misinformation, negotiation with other countries
233 and regions, formulation of policies toward schools and childcare, and relief to businesses [12]. These
234 measures were so effective that only 6 patients died from a total of 397 confirmed infections in a
235 population of more than 23 million people.

236 In the case of South Korea there was almost no increase any longer at this time. In contrast, Germany,
237 Italy and France recorded very steep increases from March 5 to 21, with increases being exponential
238 over a period of several weeks. As described above, the curves flattened out with calculated plateau
239 days until mid of April 2020 (Fig. 3 and Table 1). Another comparison is interesting: Germany and
240 France on the one hand and Japan on the other hand had roughly the same numbers of confirmed cases
241 at the beginning of March. Until the end of March (day 91), Japan, however, has managed to stabilize
242 these at under 5,000 confirmed cases, while Germany had almost 71,000 and France almost 52,000
243 confirmed SARS-Cov-2 infections. The charts show that the Asian countries have so far coped well
244 with the crisis. However, in the case of Japan, it is noticeable that the trend curve has been rising more
245 strongly again since the end of March.

246 3. Discussion and outlook

247 The situation in countries like Italy, France and Spain (not shown) was more than worrying by the
248 end of March 2020. Germany, with its very efficient health care system and a high number of ICU
249 beds, has managed to achieve the lockdown just in time and prevented an overload of the health care
250 system.

251 What was the reason for these different developments in Europe and Asia:

- 252 1) Until the turnaround, Europe mainly pursued the strategy of mitigation, with the aim of gradu-
253 ally achieving herd immunity. This led to an exponential increase in case numbers over weeks,
254 thousands of deaths, and a supercritical strain on health care systems in several countries.
- 255 2) The Asian strategy was different to that: There was a very rapid lockdown to contain the infection
256 and then the countries implemented follow-up measures with the aim of suppressing the virus
257 spread. Examples are the complete lockdown in China, and a moderate lockdown in Japan (e.g.
258 schools closed, restaurants open). In China, the number of cases was stabilized at under 100,000
259 confirmed cases (not shown) - at 1.4 billion people, and in Japan at under 5,000 infected people
260 - at 126 million. Consequently, the number of SARS-CoV-2 infected persons compared to the
261 total population was low. However, the Asian strategy is also based on the aim to avoid any
262 exponential increase of SARS-CoV-2 cases at any time. The combination of strong suppression
263 with controlled release was elegantly described as “hammer and dance” strategy [16].

264 Virus replication is stopped when the Basic Reproduction Number (R-value) of the virus drops below
265 1. In the exponential course of infection, the average of R is 2-3, i.e. each infected person infects at
266 least 2-3 people. From the epidemiological side, R must be below 1 to stop the outbreak. However,
267 this contrasts with the civil liberties of citizens. Thus a “dance phase” around the curve should be
268 followed, since a sensible and democratically legitimate balance must be constantly struck between
269 the medically and epidemiologically necessary suppression measures and the civil liberties of citizens.

270 In Japan we recently saw an increase of cases after almost stopping the spread. This might be due to
271 a more carefree behaviour of the people or a simple result of increased virus testing. Since the Asian
272 countries are ahead of the European countries Europe should learn from Asia how to manage such an
273 outbreak. Given the lack of antiviral therapy or vaccine, the following measures should be implemented
274 during the “dance” phase:

- 275 1. Large scale PCR-testing to identify and quarantine infected patients and contacts.
- 276 2. Quantifying SARS-CoV-2 transmission using epidemic control with digital real-time contact
277 tracing.
- 278 3. Serosurveillance of the population to figure out the people who have passed infection and
279 acquired immunity.
- 280 4. Maintaining social distancing and hygiene rules
- 281 5. Prohibit all major events and maintaining travel restrictions across national and international
282 borders.
- 283 6. Wearing of surgical masks or even self-made face masks is mandatory since they prevent
284 transmission of human coronaviruses and influenza viruses from symptomatic individuals.
- 285 7. Introduction of body temperature scans as an additional measure for personal protection during
286 everyday activities.
- 287 8. Protect all health- and elderly care workers with PPE including N95 /FFP3 masks.
- 288 9. Travel entry ban for persons from COVID-19 risk regions or, alternatively, quarantining those
289 persons upon entry.
- 290 10. Re-implementation of regional lockdowns in case of endemic outbreak of SARS-CoV-2.

291 For any lockdown, it is helpful to predict the time point at which no further new infections will
292 occur by using normalized case number curves. Upon reaching the plateau day, a residual time-period
293 of about 2-3 weeks must be fixed for safe release. Depicting normalized curves as seen in Fig. 3 also
294 indicates compliance of the population on the governmental recommendations.

295 Following those rules, a safe dance around the infection curve is possible to keep the population at a
296 reduced infection rate in order, to get the economy back to work and revitalise social and cultural life.

297 If there is a pandemic with a new pathogen of unknown lethality and mutation rate, a hammer
298 and dance suppression strategy should always be preferred over the strategy of herd immunity to
299 dramatically reduce the evolutionary potential for pathogens.

300 In the above-mentioned article from Tomas Pueyo a list of measures of varying effectiveness and
301 cost is given. The decision-makers in each country must determine which weapon arsenal or, to put it
302 less martial, which dancing shoes are best suited to permanently limit the spread of the virus.

303 References

- 304 [1] Lu R, Zhao X, Li J, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus
305 origins and receptor binding. *Lancet*. 2020;395:565-74.
- 306 [2] Tang X, Wu C, X. L., et al. On the origin and continuing evolution of SARS-CoV-2. *National Science Review*. 2020.
- 307 [3] Choi S, Han C, Lee J, et al. Innovative screening tests for COVID-19 in South Korea. *Clin Exp Emerg Med*. 2020.
- 308 [4] Graham RL, Donaldson EF, Baric RS. A decade after SARS: strategies for controlling emerging coronaviruses. *Nat*
309 *Rev Microbiol*. 2013;11:836-48.
- 310 [5] WHO. Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003 2003.
- 311 [6] Kinross P, Suetens C, Gomes Dias J, et al. Rapidly increasing cumulative incidence of coronavirus disease (COVID-19)
312 in the European Union/European Economic Area and the United Kingdom, 1 January to 15 March 2020. *Euro Surveill*.
313 2020;25.
- 314 [7] Bernard Stoecklin S, Rolland P, Silue Y, et al. First cases of coronavirus disease 2019 (COVID-19) in France: surveillance,
315 investigations and control measures, January 2020. *Euro Surveill*. 2020;25.

- 316 [8] Johnson HC, Gossner CM, Colzani E, et al. Potential scenarios for the progression of a COVID-19 epidemic in the
317 European Union and the European Economic Area, March 2020. *Euro Surveill.* 2020;25.
- 318 [9] Tolksdorf K, Buda S, Schuler E et al. Influenza-associated pneumonia as reference to assess seriousness of coronavirus
319 disease (COVID-19). *Euro Surveill.* 2020;25.
- 320 [10] Rothe C, Schunk M, Sothmann P, et al. Transmission of 2019-nCoV Infection from an Asymptomatic Contact in
321 Germany. *N Engl J Med.* 2020;382:970-1.
- 322 [11] Covid-19 National Emergency Response Center E, Case Management Team KCfDC, Prevention. Contact Transmission
323 of COVID-19 in South Korea: Novel Investigation Techniques for Tracing Contacts. *Osong Public Health Res Perspect.*
324 2020;11:60-3.
- 325 [12] Wang CJ, Ng CY, Brook RH. Response to COVID-19 in Taiwan: Big Data Analytics, New Technology, and Proactive
326 Testing. *JAMA.* 2020.
- 327 [13] Yang CJ, Chen TC, Chen YH. The preventive strategies of community hospital in the battle of fighting pandemic
328 COVID-19 in Taiwan. *J Microbiol Immunol Infect.* 2020.
- 329 [14] Wada K, Oka-Ezoe K, Smith DR. Wearing face masks in public during the influenza season may reflect other positive
330 hygiene practices in Japan. *BMC Public Health.* 2012;12:1065.
- 331 [15] Leung NHL, Chu DK, Shiu EYC et al. Respiratory virus shedding in exhaled breath and efficacy of face masks. *Nat*
332 *Med.* 2020.
- 333 [16] Pueyo T. Coronavirus: The Hammer and the Dance. [https://medium.com/@tomaspueyo/coronavirus-the-hammer-and-](https://medium.com/@tomaspueyo/coronavirus-the-hammer-and-the-dance-be9337092b56)
334 [the-dance-be9337092b56](https://medium.com/@tomaspueyo/coronavirus-the-hammer-and-the-dance-be9337092b56) 2020.