The coronavirus disease 2019 (COVID-19) pandemic, caused by the transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), shows a complex epidemiological course characterized by several successive waves of infection with a certain strength, duration, and rhythm. Recently, Mitchell and Zhang reported in a publication in this journal1 their intriguing finding of a “four-month intrinsic viral cycle in COVID-19” by analyzing the dynamics of COVID-19 cases for 14 countries separately and for a global dataset including 189 countries. The time span analyzed was about 1.8 years (January 22, 2020, to October 8, 2021). For the nine countries investigated in the northern hemisphere, the period of the cycle was determined to be 4.2 months (range 3.5–5.1 months).

Motivated by this interesting result, a further analysis is presented here on the basis of COVID-19 data from Switzerland.

THE FOUR-MONTH CYCLE IN COVID-19 CASES: ANALYSIS OF THE DATA FROM SWITZERLAND

As COVID-19 case data from Switzerland were not analyzed by Mitchell and Zhang,1 such an analysis has now been carried out. Data on laboratory-confirmed COVID-19 cases per 100,000 of the population as well as the SARS-CoV-2 PCR test positivity rate (i.e., the ratio of the number of positive test results to the total number of tests performed) were obtained for the period from February 24, 2020, to February 3, 2022, from the Federal Office of Public Health of the Swiss Confederation (covid19.admin.ch).

Following the analysis used by Mitchell and Zhang, the long-term trend of the data was also removed first in the present analysis. The trend was determined using a Savitzky-Golay filter with specifications to capture the yearly variability in particular (window length 365 days, 3rd order) (Figures 1A and 1B). For the time-series analysis, a different (extended and more suitable) approach was used than the one Mitchell and Zhang used. The detrended time series (COVID-19 cases and the SARS-CoV-2 PCR test positivity rate) were decomposed in a data-driven manner into intrinsic mode functions (IMFs) using the improved complete ensemble empirical mode decomposition with adaptive noise (ICEEMDAN) method2 (noise SD = 0.3, number of realizations = 200, maximum number of sifting iterations allowed = 1,000). The analytic approach based on empirical mode decomposition has already been successfully used by other authors for the analysis of epidemiological data related to COVID-19.

For COVID-19 cases, the sum of the 4th and the 5th IMFs was found to contain an oscillatory component with a periodicity of several months. In case of the SARS-CoV-2 PCR test positivity rate, the 5th IMF contained the oscillatory component of interest. For the COVID-19 cases, 4 successive oscillatory peaks were identified between the yearly maximum peaks in approximately November 2020 and January 2022 (Figure 1C). The period of the oscillation was found to be $3.6 \pm 0.9$ months. The SARS-CoV-2 PCR test positivity rate exhibited 6 oscillatory peaks that were different from the yearly ones (Figure 1D). The period of this oscillation was found to be $3.9 \pm 0.9$ months.

NOVEL INSIGHTS

The present analysis provides three results and insights with respect to the finding of Mitchell and Zhang. It could be shown that (1) a 4-month cycle is also evident in the epidemiological COVID-19 data from Switzerland, (2) the 4-month cycle is more pronounced in the SARS-CoV-2 PCR positivity rate than COVID-19 case dynamics, and (3) the ICEEMDAN-based data analysis approach is useful for a data-driven extraction of the 4-month cycle.

The fact that the 4-month cycle was more evident in the SARS-CoV-2 PCR positivity rate than the COVID-19 case dynamics supports the notion that the cycle is

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**Figure 1.** The 4-month cycle in COVID-19 cases from Switzerland (A and C) Time series of COVID-19 cases and the SARS-CoV-2 PCR positivity rate. The red lines show the long-term trend (identified. (C and D) Detrended time series (blue) and the sum of the 4th and 5th IMFs (red, left) as well as the 5th IMF (red, right). Oscillatory peaks belonging most probably to a yearly oscillation are marked with green arrows, and the oscillatory peaks belonging to the 4-month cycle are marked with orange arrows. $T$, period length.
indeed an "intrinsic viral cycle" as the authors suggest, as the SARS-CoV-2 PCR positive rate is much better able to capture the dynamics of the COVID-19 pandemic than the simple number of COVID-19 cases. This is because the number of COVID-19 cases is influenced by many factors, including the number of SARS-CoV-2 tests performed or changes in health policy to test certain populations more intensively, which makes a correct interpretation of this parameter difficult and uncertain. A better parameter is therefore the SARS-CoV-2 PCR positivity rate, which takes the number of tests performed into account. This was also the conclusion of a recent study on the epidemiological progression of the COVID-19 pandemic in Tokyo, Japan.3

The conclusion of Mitchell and Zhang can be agreed with, that is, that the 4-month cycle seems to be driven not primarily by containment measures taken, as the cycle was evident in datasets from all countries independent of the country-specific containment measures in place.

It can speculated that the yearly (seasonal) COVID-19 cycle interacts with the 4-month cycle possibly in the form of constructive or destructive interference. Coronavirus, as classic winter viruses, cause the highest infection rate in the northern hemisphere roughly between December and April (with a maximum around February).4 The warm season in the northern hemisphere countries is linked with a reduction of about 45% in COVID-19 cases, leading to a seasonal cycle, as revealed by recent modeling of epidemiological COVID-19 data.5 If this annual rhythm overlaps with the 4-month rhythm, it could, for example, lead to constructive interference with a particularly strong increase in COVID-19 infections, which we are currently experiencing in Switzerland, perhaps also due to this process, at the beginning of February 2022. It will be interesting to see whether and how the four-month cycle will manifest itself in the further course of the year in Switzerland. If it continues the pattern established to date, an increase in the PCR positivity rate due to the four-month cycle is to be expected again in spring 2022.

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DECLARATION OF INTERESTS
The author declares no competing interests.