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Commentary

Control of epidemics: Testing, vaccinations, and monitoring

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Abstract

Increasing the test-per-case ratio was recommended to reduce the number of cases and deaths per capita. In particular, due to a synchronous increase in the number of tests alongside the rise in new cases and very high levels of the tests-per-case ratio, the COVID-19 pandemic in New Zealand was largely controlled before October 2021. After February 2022, an abrupt decline in the tests-to-case ratio led to a record number of cases and deaths at a relatively high vaccination level. Recent COVID-19 mortality rates in New Zealand are comparable with the global endemic level and the global flu mortality. Thus, the existing vaccines cannot reduce the number of COVID-19-related deaths per capita. Nevertheless, the lower values of case fatality risk *CFR* in more vaccinated countries in 2020–2022 still have to encourage people to be vaccinated, especially the elderly and persons with weak immunity. A recent huge increase in the case fatality risk is connected with the decrease in COVID-19 testing. Since many cases are hidden (asymptomatic), the estimation of real epidemic dynamics and correct *CFR* values needs complicated models, taking into account asymptomatic patients, re-infections, newborns, etc. To monitor the real epidemic dynamics (e.g., to calculate the rate of increase in the real number of infectious persons over time), a new reproduction number (recently proposed by the author) can be recommended.

Keywords: Efficiency of vaccinations, Testing efficacy, Mathematical modeling of infectious diseases, Statistical methods, COVID-19 pandemic, COVID-19 in New Zealand

Commentary

Effective epidemic control on the population level means that the numbers of cases and deaths have to be as low as possible, e.g., we can use the averaged (smoothed) number of new daily cases *DCC* and deaths *DDC* per million [1,2] for different moments in order to estimate the corresponding control efficacy. The application of the relative (per capita) characteristics allows comparing the effectiveness of epidemic combating in different countries and regions, but only after taking into account other factors. In particular, very low *DCC* and *DDC* values registered in Africa during the COVID-19 pandemic [2,3] do not mean that European strategies were less effective. Much lower median population age in African countries and many asymptomatic cases in children and young people led to much lower *DCC* and *DDC* figures [4]. Higher testing level (average daily numbers of tests per thousand *DTC*) in Europe also allowed revealing more infections [4]. On the other hand, the high values of the tests-per-case ratio $TC=DTC*1000/DCC$ (or low values of the test positivity rate DCC/(DTC*1000)) allowed some countries to decrease *DCC* and *DDC* figures, and to control the COVID-19 pandemic completely even at low vaccination levels [2].

The effective epidemic control on the population level also means low values of the case fatality risk $CFR=DDC/DCC$, which allow decreasing the number of deaths even at high numbers of cases. *CFR* is the probability of dying for a person who tested positive, which can be decreased by improving immunity (e.g., due to vaccinations) and effective treatment. Case fatality risks demonstrated decreasing trends with the increase of COVID-19 vaccination levels in 2020–2022 [2,4–6], when the testing levels were high enough to register reliable figures both in the numerator

and the denominator of the *CFR* formula. This fact has to encourage people to be vaccinated, especially the elderly and persons with weak immunity [6]. Unfortunately, in 2022 and 2023, the numbers of COVID-19 cases per capita have not demonstrated any decreasing trends with the increase of the vaccination levels, and the decrease in *CFR* was not enough to reduce *DDC* values significantly [2,4–6]. We will show that the recent average daily number of deaths per million is still high in New Zealand.

Investigations of the COVID-19 pandemic dynamics presented in [2] allowed us to conclude that "increasing the test per case ratio and application of quarantine restrictions for the entire population, including vaccinated people, can be recommended to reduce the negative consequences of epidemics". It is quite difficult to test the feasibility of these recommendations using the example of the COVID-19 pandemic, since quarantine restrictions were lifted before publication of the paper [2] and most countries stopped reporting new cases to WHO [3].

According to [2], New Zealand gives us examples of a synchronous increase in the number of tests with an increase in the number of new cases and very high levels of the tests-per-case ratio *TC* before October 2021. The epidemic was completely controlled since the average number of new daily cases *DCC* and deaths *DDC* per million were less than 15 and 0.025, respectively. After February 2022, an abrupt decline in the *TC* values led to a record number of cases and deaths at a relatively high vaccination level.

Let us analyze the recent COVID-19 situation in New Zealand with the use of datasets available in [7]. In 7 days (17–23 November 2025), 162 new cases and 5 new deaths were registered. Taking into account the population of New Zealand 5.3 million [8], we can calculate the values of *DCC*=162/(7*5.3)=4.4 and *DDC*=5/(7*5.3)=0.135. Close figures can be obtained using the recent records during 30 days (25.10.2025–23.11.2025), [7]: *DCC*=695/(30*5.3)=4.4 and *DDC*=16/(30*5.3)=0.1. Both *DCC* values are much lower than the global lower endemic level 37.2, calculated in [5] with the use of 2022 datasets [1,9]. Nevertheless, *DDC* figures are comparable with the lower endemic level 0.124, [5] and much higher than the number of deaths before October 2021 despite very high vaccination level (as of November 2025, 82.9% of 12+ have completed primary course; 57.2% of eligible 50+ have received second booster; 71.0% of eligible 18+ have received first booster, [10]). Recent *DDC* figures in New Zealand are close to the global flu mortality 0.1–0.18, [5,11].

The low number of new cases registered in New Zealand in November 2025 is a result of reduced testing levels. The decreasing trend in *DCC* values started in many countries already in 2023 and caused the significant increase of the case fatality risk *CFR*=*DDC*/*DCC*, [2,4]. E.g., in New Zealand, *DCC* was equal to 1,079 in 2022 and 245 in 2023; *CFR*=0.0011 and 0.003, respectively, [4]. Unfortunately, we have found no recent information about the daily number of tests per thousand (*DTC*), but very high levels of the case fatality risk for periods 17–23 November 2025 (*CFR*=5/162=0.031) and 25.10.2025–23.11.2025 (*CFR*=16/695=0.023) indicate a further decrease in the testing level in comparison with June 2022, when *DTC* was around 0.6, [12]. Since many cases were not revealed, the estimation of real epidemic dynamics and correct *CFR* values needs complicated models, taking into account asymptomatic patients, re-infections, newborns, etc (e.g., [13–15]).

It is possible to estimate the minimal testing level, which could make the COVID-19 epidemic controllable in New Zealand. Taking into account the critical value of the tests per case ratio TC^* =200, which was enough to control the epidemic before October 2021 (see Figure **7** in [2]), and the recent *DCC* value 4.4, we can conclude that the daily number of tests per thousand has to be higher than DTC^* =200*4.4/1000=0.88. Due to the large number of unregistered cases, this is only a lower estimation. But the control of COVID-19 looks realistic in New Zealand, where the maximum *DTC* values were approximately 10 times higher in August 2021 and allowed stopping an abrupt increase in the daily number of new cases (see Figure 7 in [2]).

To control new waves of COVID-19 and other epidemics, we need to monitor their dynamics. In particular, the real-time estimations of the effective reproduction numbers R_t [16] can be used. Since the definition of R_t and methods of its estimation [17–23] use only visible (registered) numbers of cases, they cannot reflect the dynamics of epidemics with many hidden (asymptomatic) patients. To monitor the real epidemic dynamics (e.g., to calculate the rate of increasing the real numbers of infectious persons over time τ), a new reproduction number $R_\tau(t)$ was introduced [24]. The method of its estimation uses the numbers of visible cases only and was successfully applied for the pertussis epidemic in England [24], the COVID-19 pandemic in Austria and Tanzania [25], and for monitoring a new COVID-19 wave in Ukraine in the summer of 2025, [26].

Ethical Approval Statement

No human or animal experiments were used in the study. The statistical information used is public and available on the Internet.

Author statements

The author declares no conflict of interest.

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