



Covid-19: What is the R number?

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It's been driving policy decisions since covid-19 emerged in late 2019, but what is the R number, and does it matter, asks Elisabeth Mahase

What is the R number?

The R number could refer to either the basic reproduction number, known as the R nought or zero (R_0), or the effective reproduction number (R_e).

R_0 describes how many people each infected person will infect on average, assuming that there is no pre-existing immunity in the community. It is often estimated using three factors: the duration of contagiousness after a person becomes infected, the likelihood of infection in each contact between a susceptible person and an infectious person or vector, and the frequency of contact.

R_e is the number of people that can be infected by an individual at any specific time, and it changes as the population becomes increasingly immunised, either through individuals gaining immunity after being infected or through vaccination, and also as people die. R_e can also be affected by people's behaviour, such as by social distancing. R_0 and R_e are often confused or just referred to as the R number.¹

What are the R_0 and R_e for SARS-CoV-2?

SARS-CoV-2, the coronavirus that has caused the covid-19 pandemic, has an estimated R_0 of around 2.63, says the University of Oxford's COVID-19 Evidence Service Team. However, estimates vary between 0.4 and 4.6. This is not unusual, as R_0 estimates often vary, with different models and data being used to calculate it. Measles, for example, has been assigned R_0 values of between 3.7 and 203.03.²

The R_e will also vary across different countries and between regions. The UK prime minister, Boris Johnson, said on 10 May that the R_e in England was currently "between 0.5 and 0.9, but potentially just below 1." In Scotland, first minister Nicola Sturgeon said it was between 0.7 and 1.

In Germany, the Robert Koch Institute reported on 9 May that the R_e had risen to 1.1 just days after the country began to ease lockdown measures. The same effect was also seen in Denmark when it reopened primary schools in April: the R_e rose from 0.6 to 0.9.

Is the R_e important?

Many politicians have pointed to the R_e as an important measure to determine how well their country is responding to the pandemic and what can happen next. German chancellor Angela Merkel appeared on television to explain the reasoning behind her government's strategy, referring to the reproduction number.³ Meanwhile Boris Johnson told the public on 10 May that easing lockdown in England would depend on whether the reproduction number could be kept down.

It is often presented in simple terms: if the R_e is above 1 then the outbreak is expected to continue, but if it can be reduced to less than 1 the outbreak will end. This is because if each person who is infected in turn infects less than one person, the outbreak will reduce; an R_e of 0.5 would mean that 10 infected people would infect five others, who would then infect another 2.5. In contrast an R_e above 1 would mean that the outbreak would increase exponentially.

However, experts have warned that without up-to-date and comprehensive data the reproduction number is a "blunt monitoring tool."

Azra Ghani, professor in infectious disease epidemiology at Imperial College London, said, "At present we are estimating both R and the infection rate from data on hospitalisations. These form only a small fraction of all infections and represent an estimate of transmission that occurred 1-2 weeks earlier—and are therefore a blunt monitoring tool.

"Models or model based estimates (such as R) can be helpful in interpreting data trends but should never be viewed as a surrogate for good data. Only with extensive surveillance and rapid testing of suspect cases in the wider community, in hospitals, and in care homes, and other places at high risk, can we be truly confident that the epidemic is in decline and that it is safe to relax measures."

- 1 Centre for Evidence-Based Medicine. "When will it be over?": an introduction to viral reproduction numbers, R_0 and R_e . Apr 2020. <https://www.cebm.net/covid-19/when-will-it-be-over-an-introduction-to-viral-reproduction-numbers-r0-and-re>.
- 2 Delamater PL, Street EJ, Leslie TF, Yang YT, Jacobsen KH. Complexity of the basic reproduction number (R_0). *Emerg Infect Dis* 2019;25:1-4. 10.3201/eid2501.171901. 30560777
- 3 Alvarez B. Twitter. 16 Apr 2020. <https://twitter.com/BenJAlvarez1/status/1250563198081740800>.

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