Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Coronavirus

How do we live with covid-19?

The UK government has said it is now time to "learn to live with covid". Here's what that looks like, write **Graham Lawton**, **Michael Le Page**, **Adam Vaughan** and **Clare Wilson**

WITH more than half of adults in the UK having received two doses of vaccine against covid-19, the UK government has decided that the time has come to lift most restrictions in England and get on with life alongside the virus. Since 19 July, people in England have been free to meet up with whoever they want, wherever and whenever they like, for the first time since November 2020, and nightclubs have reopened for the first time since March 2020. Masks and social distancing are largely no longer mandated.

But it won't quite be business as usual, with a predicted spike in cases reaching 100,000 per day in mid-August. So what does it mean to "live with covid" once restrictions have lifted, and what insights can we glean for those living elsewhere too?

What will 100,000 cases a day mean?

The largest spike in recorded cases in the UK so far was in January 2021, which reached around 60,000 a day. But the current wave is different to those that came before. Thanks to vaccines protecting those most at risk, and because the virus is now spreading more among younger people, the link between cases and hospital admissions and deaths has been weakened – but not broken.

Overall, UK government advisers say there is now a fourfold lower chance of hospitalisation and roughly tenfold lower chance of death, compared with the UK's second wave of covid-19, which started in August 2020.

The earliest the next wave might peak is predicted to be mid-August, although the timing hinges on how fast behaviour flips back to pre-pandemic ways, including how many close contacts people make each day, whether face masks are worn in crowded places and how many people work from home.

A central case modelled for the Scientific Advisory Group for Emergencies (SAGE), which advises the UK government,

"I don't think I can be a safe member of society when we have 100,000 cases a day"

suggests there would be 100 to 200 deaths and 1000 to 2000 hospitalisations daily at the peak.

However, there is a lot of uncertainty over the figures, because the models are sensitive to small changes in the number of unvaccinated people, the efficacy of vaccines against the delta variant and more. This variation will determine whether hospitals become overwhelmed. In the worst case, deaths and hospital admissions could exceed the peaks seen in spring 2020.

One small positive is people are spending less time in hospital than in past waves, because most are younger. However, Kit Yates at the University of Bath, UK, points out that any increase in hospitalisations will hamper routine treatment, adding to the backlog that has built up during the pandemic. "Certainly, with 100,000 cases, we are going to see pressure on the NHS and routine care being cancelled," he says.

Beyond hospitalisations and deaths, SAGE sees three main risks from a high number of infections: a rise in long covid cases, disruption due to workplace absences and new variants emerging. High prevalence and incidence also makes contact tracing harder.

A waiter in central London, before restrictions were lifted

The overall impact of a third wave may eventually force governments to reimpose some restrictions, says Mark Woolhouse at the University of Edinburgh, UK. "I think it's unlikely. But they do have to prepare for it and plan for it," he says.

Will life feel normal for some people?

There will be some elements of normality for people who are younger, have no underlying health conditions and are fully vaccinated.

However, even if people know they are relatively low risk, they may still be concerned about the possibility of passing the virus on to those who are more vulnerable, given vaccines aren't a guarantee against transmission.

"I'm at low risk, I've had two doses of Pfizer," says Christina Pagel at University College London. "I'm not worried about catching it for me, but I'm very worried about passing it on. Both my parents are extremely clinically vulnerable. I want to see them and I'm not going to do that as freely with these high cases. I don't think I can be a safe member of society when we have 100,000 cases a day."

High cases and the lifting of restrictions may make a large number of people anxious too, says Elise Paul, also at UCL. In June, the percentage of people worried about catching and becoming seriously ill from covid-19 was at

DANIEL LEAL-OLIVAS/AFP VIA GETTY IMAGES

its lowest levels since the start of the pandemic, according to an ongoing survey that she runs. That is expected to rise. "I don't think we are going to see a sudden return to normalcy," says Paul.

What about vulnerable groups?

Those most at risk of getting severely ill from covid-19 include older people, especially those living in care homes, and younger adults with medical conditions such as cancer or a weak immune system. Many of them have been told to "shield" or stay at home when cases have been high.

All such groups in the UK will by now have been offered two vaccine doses, but some will still catch the virus. With outbreaks being seen again in care homes, staff are learning to recognise the different covid-19 symptoms in older people who are vaccinated, says Adam Gordon at the University of Nottingham, UK. Rather than respiratory symptoms and fever, vaccinated residents may become withdrawn, delirious and stop eating and drinking, says Gordon. "The jury's still out on the extent of harm that these less severe infections can cause."

Rising numbers of covid-19 cases, coupled with less social distancing and mask-wearing in public spaces, makes it riskier for vulnerable people to mix with others. The UK government has advised those who are extremely vulnerable that they may wish to take extra precautions, such as only meeting people outside and avoiding those who haven't been fully vaccinated.

A recent study of more than 7 million people in England found that most of those with long-term health conditions, such as asthma and heart disease, got the same level of vaccine protection and antibody response as the general public. But it also found that people with weak immune systems were less protected, with vaccine effectiveness of 74 per cent, compared with about 85 per cent in the general population. And it is likely to be lower in people with the severest immune deficiencies, says Herb Sewell at the University of Nottingham.

Some people with very weak immune systems can even have no antibodies to the coronavirus after two vaccine doses. One such person is Lizi Jackson-Barrett of Romford in the UK, who has a genetic immune deficiency. "There's a real misconception that vulnerable people are all safe," says Jackson-Barrett. "There are huge numbers of us who effectively remain unvaccinated."

What will winters look like?

Winter usually means outbreaks of respiratory viruses including influenza, respiratory syncytial virus (RSV) and those that cause common colds. They barely touched us last winter, suppressed by measures to limit the spread of covid-19. But what about after restrictions are lifted?

Making global predictions is almost impossible, says Azra Ghani at Imperial College London. "Every country is almost unique," she says. But the UK at least can probably expect a worse-than-usual flu season, according to a new report from the Academy of Medical Sciences.

"There is some evidence that infection with other viruses can make covid-19 symptoms a lot worse"

There are still multiple unknowns, including how bad this winter's flu strain will be, how effective the flu vaccine is and how much natural immunity has waned. But the UK can expect 1.5 to 2.2 times the normal number of flu cases, says Ghani, a member of the report's expert advisory group. Flu normally kills 10,000 to 30,000 people a year in England.

RSV is also expected to be up to twice as prevalent than it is in a normal year, which sees 20,000 children under 5 admitted to hospital. The vast majority recover.

There is also the added risk of co-infection, which is when an individual is infected with two or more viruses at the same time, including the SARS-CoV-2 virus that causes covid-19. "Co-infection is quite common in the winter months – some people can harbour three at the same time – and there is evidence that RSV can make covid-19 symptoms quite a lot worse," says Stephen Holgate at the University of Southampton, UK, the report's chair.

This all points to a bleak midwinter in England. "The NHS is already under pressure, so is likely not to be able to cope with these challenges," he says.

How many deaths are acceptable?

Opening up society will mean that more people will die from covid-19 than if restrictions remained. No country has explicitly said the level of covid-19 deaths it will tolerate, but some countries, such as New Zealand, have effectively decided to accept no infections or deaths, instead pursuing an elimination strategy.

Ministers have acknowledged that the ending of all covid-19 restrictions in England will lead to more deaths, but haven't said how many are acceptable.

Modelling by Anne Cori at Imperial College London and her colleagues suggests there could be anything from 9400 to 113,000 deaths from covid-19 in England between 2 July 2021 and 1 June 2022, depending on how people behave and how well the vaccines work, but she stresses the uncertainties. "I would not emphasise any specific numbers," says Cori.

Other modellers agree. "Forecasting death numbers is much more difficult than anything else," says Matt Keeling at the University of Warwick, UK.

Even countries that have pursued an elimination strategy may be forced to tolerate waves of infections and deaths when they open up after vaccination campaigns are complete. ›

Will there be an epidemic of long covid?

As covid-19 is allowed to spread freely, many more people will end up with long covid. Just how many is impossible to predict, however.

There are widely differing estimates of how many infected people get long covid. When Nina Langeland at the University of Bergen and her colleagues followed 250 or so people in Norway who tested positive for covid-19 but didn't need to go to hospital, the team found half of those aged between 16 and 30 years still had symptoms six months later, ranging from loss of taste and smell to fatigue and memory problems.

"I do see our findings as a good reason to immunise teenagers," says Langeland, "to avoid long-term symptoms, which could affect education and studying."

"Long covid is a good reason to immunise teenagers – it could affect education and studying"

By contrast, Tim Spector at King's College London and his colleagues estimate that just 1 in 100 people aged around 20 have long covid after three months. Much of the reason for these differences is due to how long covid is defined, says Spector, with some studies counting any lasting symptom, however minor.

"We've redefined it to say it's a symptom that persists for more than 12 weeks that interferes with your normal functioning or activities," he says. His team estimates that 180,000 people in the UK have or have had long covid according to this definition, and this number is currently growing by 700 each day.

What is clear from his research is that vaccination greatly reduces the risk of getting long covid. "It's maybe a twentieth of what it would have been," says Spector. This is mostly because vaccination reduces the risk of being infected in the first place, but his team's findings suggest that the risk is also halved in those who get infected despite being vaccinated.

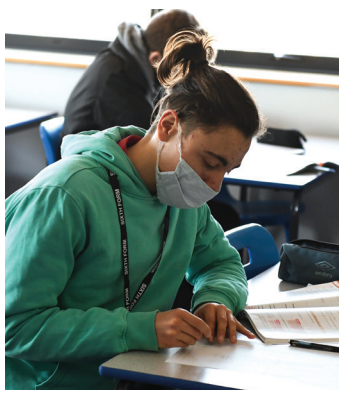
What will life be like for children?

England's new covid-19 strategy will mean big changes in schools for most under-18s. The approach this year was to manage children in small groups and avoid them mixing. This bubble system will no longer apply from September, meaning children's social and school lives will be much less constrained.

Schools in England are also dropping face coverings – although they may make temporary returns if there is a school outbreak, the UK government has said.

The new approach is striking because most under-18s in the UK haven't yet been vaccinated and so their infection rate is soaring. This also puts others at risk, Russell Viner, former president of the Royal College of Paediatrics and Child Health, told a Royal Society of Medicine conference earlier this month.

"When children and young people will be the only substantial part of the population that are not vaccinated, we will make true what has been claimed all through the pandemic – children and young people become the source of most infections to vulnerable adults," said Viner.



ANTHONY HARVEY/SHUTTERSTOCK

Students will no longer need to wear face masks in England

What new tech can we expect?

In the 1800s, a growing realisation that poor sanitation was a public health risk led to cities around the world building clean water supplies and sewers. There are now calls for a similar revolution in indoor air quality. "We should have virus-free air indoors," says Lidia Morawska at the Queensland University of Technology in Brisbane, Australia.

She and 40 other researchers from around the world recently called on the World Health Organization to strengthen indoor air quality standards to account for airborne pathogens such as SARS-CoV-2.

According to Morawska, indoor ventilation standards currently focus on temperature, humidity, CO_2 levels and odour. Morawska and others think they should be upgraded to include higher airflow, filtration and disinfection, and that measures of air quality are made publicly available.

One relatively straightforward way to do the latter is through levels of CO_2. "It's a kind of proxy measure for the amount of air that's being shared," says Trisha Greenhalgh at the University of Oxford. Belgium's coronavirus commissioner recently recommended such read-outs for all indoor public spaces and ordered hotels, restaurants, bars and gyms to do so.

Some places are mandating higher standards. In New York City, for example, classrooms must have at least two functioning methods of ventilation, and schools' ventilation status is openly published on a website.

Various groups are working on warning sensors that detect the virus itself in air and dust. Sensors could be embedded in face masks and clothing and made into wearable virus monitors. UV light is also being investigated as a method of disinfecting the air.

Personal technology can help, too. "We're doing a lot with wearables," says Mike Snyder at Stanford University in California. Data from smartwatches can detect warning signs of covid-19 three to four days before symptoms start. "We can tell when you're getting ill because your heart rate jumps up," he says.

What about new treatments?

People who are sick enough to be in hospital may already receive medicines, such as the steroid dexamethasone, and an artificial antibody, tocilizumab, both of which dampen the unhelpful overreaction to the virus by the immune system. But the search is on for treatments that people with milder illness could use at home.

Any drug that works as a treatment could also make a preventative medicine, says Philip Bath at the University of

Nottingham. Preventative drugs could be taken by vulnerable people who have been in contact with known cases, or if infection rates surge locally. Bath is about to start a trial of two possible preventatives in care homes.

Other trials have already started. Antiviral drugs work by blocking the virus's life cycle. In April, the UK set up an Antivirals Taskforce that aims to have at least two such medicines ready for home use by the end of this year. This month,

80%
Reduction in infections in intensive care staff using novel nasal spray

one leading contender, called molnupiravir, was found to reduce hospital admissions in people with mild covid-19 in India.

Some medicines used to treat other illnesses have been rushed into covid-19 trials. Several are being investigated that raise nitric oxide levels, which dilates the airways and blood vessels to make breathing easier. In a different approach, a compound from seaweed which is sprayed up the nose works by coating the nasal passages to block virus entry. A trial in Argentina found it cut the number of intensive care staff who caught the virus by 80 per cent.

More innovative approaches are at an earlier stage of development. One is tiny fragments of antibodies that can be inhaled, called nanobodies. These "decoy particles" are covered with ACE2, the molecule on human cells the virus normally binds to.

Will we live in fear of dangerous variants?

Yes, is the short answer. As long as SARS-CoV-2 continues to circulate in people or animals anywhere in the world, new – and old – variants will remain a threat.

The further evolution of the virus depends on how many chances it has to mutate and what selective pressures are on it. In the UK, with high case numbers and high vaccination levels, conditions are ideal for variants to emerge that are even better at evading vaccine protection.

"The likelihood of this happening is unknown, but such a variant would present a significant risk both in the UK and internationally," SAGE has warned.

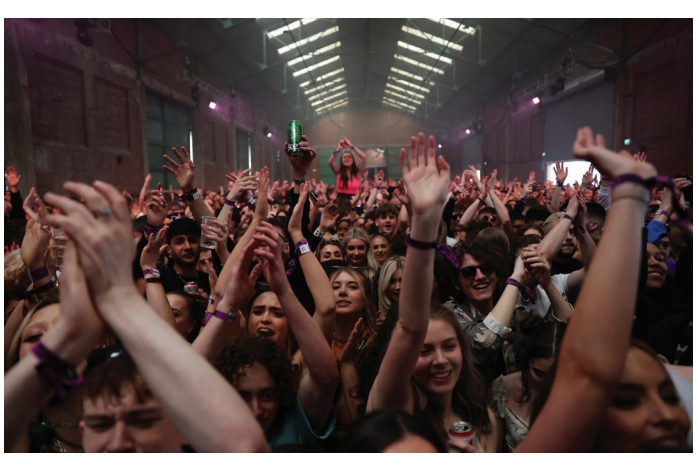
This risk has led to criticism of England's approach from other countries. However, with case numbers and vaccination levels rising in many countries, new escape variants – that can at least partially evade vaccines or natural immunity – could emerge just about anywhere. In fact, they are.

In addition to the four "variants of concern" – alpha, beta, gamma and delta – the World Health Organization has already named four "variants of interest" – eta, iota, kappa and lambda – and is monitoring many more emerging variants. It remains to be seen if any are more dangerous than delta.

However, it is unlikely that any new variant will completely dodge the immune protection from vaccines or previous infections, so hospitalisation and death rates should be lower in future waves caused by new variants, as the UK is seeing with delta.

The threat from variants isn't going away anytime soon. In a few decades, younger people might have no immunity to the original SARS-CoV-2 variants. If these lurk in an animal reservoir and get reintroduced into people, they could trigger yet another wave of infections. This is thought to be why younger people were harder hit in the 2009 swine flu pandemic.

Clubs in England are now open for the first time since March 2020



REUTERS/CARL RECINE

What's the endgame?

The covid-19 pandemic will one day be history, but the virus that caused it will not. Just as the 1918 influenza virus is still with us, we will have to learn to live with SARS-CoV-2 and its descendants, says Neil Ferguson at Imperial College London. But what form that relationship will take is unknown.

According to Amalio Telenti at Scripps Research Institute in La Jolla, California, we are currently in a transition period as vaccines wrestle the pandemic under control. After this, he says, we won't eliminate the virus, but it will become endemic, meaning it is a constant presence that ebbs and flows over years or decades.

Once this happens, broadly speaking there are three scenarios, he says. The worst case is a future with waves of severe disease like the deadly flu outbreaks of 1928-29 and 1934-36, both of which were caused by descendants of the 1918-19 flu virus. This scenario could occur if global vaccination rates remain too low, immunity doesn't persist or the virus mutates so it can evade the immune response or becomes more virulent.

The second and most likely scenario, he says, is that SARS-CoV-2 turns into a seasonal virus like flu. But that would still mean intermittent epidemic peaks, as with flu.

The best-case scenario is that the virus fades to become just another seasonal coronavirus like the four that cause the common cold.

Ferguson agrees that the middle scenario is more likely, with low levels of infection and flare-ups where levels of immunity decline. "It will become a classic endemic respiratory disease which we manage, probably through vaccination," he says.

But that wouldn't entail any return to pandemic restrictions, says Graham Medley at the London School of Hygiene & Tropical Medicine. "We don't put special measures in to deal with the flu and in the same way I don't think we'll have special measures in to deal with the coronavirus."