

Annex A: Science of COVID-19

This note is designed to address outstanding questions around the science of COVID-19 with answers provided thematically.

Background

COVID-19 is the disease caused by the coronavirus SARS-CoV-2. Although primarily a respiratory tract infection, it often causes gastroenteric symptoms and it is increasingly recognised as a disease affecting many tissues. SARS-CoV-2 is highly infectious. The basic reproduction number, R_0 , is approximately 3 (compared to ~1.5 for influenza). This means that in a population where all are susceptible and no control measures are in place, each infected person will infect on average three others, causing exponential spread. The infection fatality rate (the proportion of infected individuals who die) of SARS-CoV-2 is estimated to be around 0.5-1%.

Deaths in UK

The Department of Health and Social Care has temporarily suspended publication of daily figures on deaths, pending an urgent review by Public Health England (PHE). The series used up to Friday 17th July shows the number of deaths in the UK in any setting (hospital, care home, private home etc) for which there has been a positive lab-confirmed test for COVID-19. PHE have been asked to review this and consider whether a time limit should be applied between date of test and date of death.

Separately, the Office for National Statistics (ONS) publishes weekly figures on death registrations where COVID is suspected or confirmed on the death certificate. These are different sources, measuring a slightly different thing. The ONS figures tend to be higher, because they include cases where COVID is suspected, as well as confirmed cases. Since the epidemic began, ONS figures show 55,071 registered deaths (up to 3 July). The published daily series on deaths where there was a positive lab-confirmed test shows 44,968 deaths up to 13 July.

Table: 1. Cumulative number of deaths in all-settings in the UK, for cases where the individual had a positive lab-confirmed test (no time limit applied between date of test and date of death).

Number of deaths as at 5pm on:	England	Scotland	Wales	Northern Ireland	United Kingdom
31 March 2020	2,901	69	98	28	3,096
01 April 2020	3,504	97	117	30	3,748
30 April 2020	24,781	1,475	925	347	27,528
31 May 2020	34,889	2,362	1,347	523	39,121
30 June 2020	39,354	2,485	1,516	551	43,906
01 July 2020	39,434	2,486	1,524	551	43,995
02 July 2020	39,567	2,487	1,525	552	44,131
03 July 2020	39,626	2,488	1,530	554	44,198
04 July 2020	39,647	2,488	1,531	554	44,220
05 July 2020	39,663	2,488	1,531	554	44,236
06 July 2020	39,815	2,488	1,534	554	44,391
07 July 2020	39,936	2,489	1,538	554	44,517
08 July 2020	40,018	2,490	1,540	554	44,602
09 July 2020	40,066	2,490	1,540	554	44,650
10 July 2020	40,213	2,490	1,541	554	44,798
11 July 2020	40,234	2,490	1,541	554	44,819
12 July 2020	40,245	2,490	1,541	554	44,830
13 July 2020	40,379	2,490	1,543	556	44,968

Table: 2. Weekly count of registered deaths involving COVID-19. Figures are published by ONS.

Week number	Week ended	England	Scotland	Wales	Northern Ireland	UK
1	03-Jan	0	0	0	0	0
2	10-Jan	0	0	0	0	0
3	17-Jan	0	0	0	0	0
4	24-Jan	0	0	0	0	0
5	31-Jan	0	0	0	0	0
6	07-Feb	0	0	0	0	0
7	14-Feb	0	0	0	0	0
8	21-Feb	0	0	0	0	0
9	28-Feb	0	0	0	0	0
10	06-Mar	0	0	0	0	0
11	13-Mar	5	0	0	0	5
12	20-Mar	100	11	2	1	114
13	27-Mar	515	62	21	9	607
14	03-Apr	3330	282	134	55	3801
15	10-Apr	5899	609	304	76	6888
16	17-Apr	8335	650	409	101	9495
17	24-Apr	7806	661	413	128	9008
18	01-May	5748	527	281	124	6680
19	08-May	3716	415	211	84	4426
20	15-May	3624	336	180	74	4214
21	22-May	2455	230	134	53	2872
22	29-May	1715	131	105	49	2000
23	05-Jun	1488	89	100	20	1697
24	12-Jun	1057	69	57	21	1204
25	19-Jun	744	49	39	17	849
26	26-Jun	574	35	30	12	651
27	03-Jul	497	17	35	11	560

The ONS data source provides the most readily accessible source for demographic breakdowns by age, gender and other factors.

Table: 3. UK registered deaths up to 3 July, broken down by age and gender.

	Males	Females	Persons
Under 1 year	2	0	2
01-14	2	2	4
15-44	343	224	567
45-64	3,403	1,780	5,183
65-74	5,210	2,856	8,066
75-84	10,505	7,381	17,885
85+	10,576	12,789	23,365

UK figures on COVID deaths do not provide a routine breakdown by ethnicity, because death registration systems in England and Wales do not routinely collect ethnicity data. The best available source on ethnicity for COVID deaths is the published weekly series of deaths in hospital in England, published by NHS England & Improvement. The table below provides the latest figures.

Table: 4. Deaths in hospital in England, for patients who have tested positive for COVID-19, data up to 4pm on 8th July.

Ethnic group	Count	Percentage	Percentage (excluding null and not stated)
Total	28,993	100%	100%
British (White)	21,138	73%	80%
Irish (White)	253	1%	1%
Any other White background	894	3%	3%
	22,285	77%	85%
White and Black Caribbean	46	0%	0%
White and Black African (M)	15	0%	0%
White and Asian (Mixed)	34	0%	0%
Any other Mixed background	68	0%	0%
	163	1%	1%
Indian (Asian or Asian British)	775	3%	3%
Pakistani (Asian or Asian British)	494	2%	2%
Bangladeshi (Asian or Asian British)	170	1%	1%
Any other Asian background	425	1%	2%
Caribbean (Black or Black British)	643	2%	2%
African (Black or Black British)	425	1%	2%
Any other Black background	222	1%	1%
Chinese (other ethnic group)	82	0%	0%
Any other ethnic group	633	2%	2%
	3,869	13%	15%
Not stated	2,397	8%	
No match	279	1%	
	2,676	9%	

Risk of serious illness from COVID-19 associated with age, gender, ethnicity and underlying health conditions

The most important risk factor is advancing age with risk increasing steadily for men age over 50 and women age over 60 years. At all ages, being male confers additional risk. Additional risk is associated with obesity and pre-existing disease of the liver, lung, heart, kidneys or diabetes. Young children are very unlikely to get severe COVID-19. People from ethnic minorities, particularly Black and South Asian, have higher rates of COVID-19 diagnosis, of admission to critical care and of death. A complex, interconnected range of factors may be involved. Some will be social and economic factors but biological vulnerabilities other than comorbidities may also be part of this.

Impact on BAME groups and steps taken to inform and protect

The PHE review showed the highest age-standardised diagnosis rates of COVID-19 per 100,000 population were in people from Black ethnic groups (486 in females and 649 in males) and the lowest were in people of White ethnic groups (220 in females and 224 in males). Critical care admission was 28% more likely in South Asian and 36% more likely in Black ethnic groups, compared to the White group. This was after considering age, sex, location, deprivation and comorbidities. The PHE review found that after accounting for the effect of age, sex, age, deprivation and region, people of Bangladeshi ethnicity had around twice the risk of death compared to people of White British ethnicity. People of Chinese, Indian, Pakistani, Other Asian, Caribbean and Other Black ethnicity had between 10-50%

higher risk when compared to White British. The effect of comorbidities or occupation were not considered for these analyses. The most recent ONS analysis shows that people from a Black ethnic background are at a greater risk of death involving COVID-19 than all other ethnic groups.

The PHE recommendations cover a wide range of areas which align with the work being led by the Minister for Equalities. The Government will consider them carefully in deciding where further action is needed.

A research call by the National Institute for Health Research (NIHR) and UK Research and Innovation (UKRI) has jointly called for research proposals to investigate emerging evidence of an association between ethnicity and COVID-19 incidence and adverse health outcomes. The funded studies will be announced shortly.

To increase accessibility, government advice, guidance and the support measures announced were translated into over 25 different languages. Specific, targeted engagement has already taken place with stakeholders representing communities across the country on health, employment, support for SME businesses, and safely practising faith during this period. The Race Disparity Unit has been working closely with faith leaders, the voluntary sector, community representatives and BAME business leaders to ensure that advice and relief measures announced are available to all.

Risk analysis

Early in the pandemic expert doctors identified specific medical conditions, based on what we knew about the virus at the time, which placed some people at greatest risk of severe illness from COVID-19. This identified group became the clinically extremely vulnerable group, who were advised to shield to protect themselves.

Subsequently the Chief Medical Officer commissioned NERVTAG, the New and Emerging Respiratory Virus Threats Advisory Group in to do a large, in depth piece of work to risk stratify the population based on their risk from COVID-19 to create a far more detailed understanding of which individuals are more likely to be vulnerable. This work is ongoing and will be key to our future risk approach.

The R number

The reproduction number (R) is the average number of secondary infections produced by one infected person. An R number of 1 means that on average every person who is infected will infect 1 other person. If R is greater than 1 the epidemic is growing, if R is less than 1 the epidemic is shrinking. R can change over time. For example, it falls when there is a reduction in the number of contacts between people, which reduces transmission. R is not the only important measure of the epidemic. R indicates whether the epidemic is getting bigger or smaller but not how large it is. The number of people currently infected with COVID-19 very important. R should always be considered alongside the number of people currently infected. If R equals 1 with 100,000 people currently infected, it is a very different situation to R equals 1 with 1000 people currently infected.

R is an average value that can vary in different parts of the country, communities, and subsections of the population. It cannot be measured directly so there is always some uncertainty around its exact value.

The published R value is produced by SPI-M (Scientific Pandemic Influenza Group on Modelling) and approved by SAGE. R is estimated by a range of independent expert modelling groups based in universities and PHE. The modelling groups present their individual R estimates to the Science Pandemic Influenza Modelling group (SPI-M). Attendees compare the different estimates of R and SPI- M collectively agrees a range which R is very likely to be within.

SPI-M individual modelling groups use a range of data to estimate R including:

- Epidemiological data such as hospital admissions, ICU admissions and deaths. It generally takes 2-3 weeks for changes in R to be reflected in these data sources, due to the time between infection and needing hospital care.
- Contact pattern surveys that gather information on behaviour. These can be quicker (with a lag of around a week) but can be open to bias as they often rely on self-reported behaviour.
- Household infection surveys where blood samples and swabs are performed on individuals which can provide estimates of how many people are infected.
- Longitudinal surveys (which sample the same people repeatedly) allow a direct estimate of the infection rates.
- Different modelling groups use different data sources to estimate R using complex mathematical models that simulate the spread of infections. Some may even use all these sources of information to adjust their models to better reflect the real-world situation.

There is uncertainty in all these data sources, which is why R estimates can vary between different models, and why we do not rely on one model; evidence is considered, discussed and R is presented as a range.

Latest R number in the UK

The latest R number range for the UK as of 17 July is 0.7-0.9.

The latest growth rate per day for the UK as of 17 July is -5% to -1%.

The values are shown as a range, the most likely true values are somewhere towards the middle of this range.

Table: 5. Combined estimate of R and the growth rate in the UK and four nations (90% confidence interval). 17th July.

Nation	R	Growth rate per day
England	0.8 – 1.0	-4% to 0%
Scotland*	0.5 – 0.9	-9% to +1%
Wales*	0.6 – 0.9	-7% to +1%
Northern Ireland*	0.4 – 0.9	-11% to +1%
UK	0.7 – 0.9	-5% to -1%

**Care should be taken when interpreting these estimates as they are based on low incidence and/or clustered outbreaks within this area.*

Impact of border measures

Imported cases matter most when the UK has a low level of infection. When domestic transmission is very high imported cases are such a small amount of total that they are make no significant difference to the epidemic. As the UK moves to situation where local incidence

and prevalence is much lower, imported cases could become a higher proportion of the overall number of infections and so preventing them can have some benefit. This is a gradual process, so there is not a 'threshold'. It is however the case that once rates of domestic transmission are low it is potentially a material issue.

Monitoring the R number in other countries

R is not the only important measure of an epidemic. R indicates whether the epidemic is getting bigger or smaller but not how large it is. If R equals 1 with 100,000 people currently infected, it is a very different situation to R equals 1 with 1000 people currently infected. As such we are not monitoring R as such in other countries. But we are monitoring point prevalence, and other epidemiological intelligence. Point prevalence is an estimate of the proportion of the population that is currently infectious. As such provides a rough estimate of the probability that any given direct traveller to the UK will be infectious.

International comparisons of excess deaths

A measure of excess deaths can be constructed by comparing the number of deaths in a given time period this year with the average number of deaths in the same period in previous years. This measure does not rely on the definition of a COVID-19 death and takes account of any additional deaths that have occurred for reasons other than COVID-19, including those that are indirectly a result of the pandemic, for example because other health care has been delayed.

International comparisons of excess deaths are hindered by the fact that countries publish data for different time periods and with a different time lag in reporting. Some data are provisional and are subject to change. Comparisons will become easier over time as more data become available.

Pandemic timeline

Please see below for a brief overview of the pandemic timeline:

31 December - China contacted the WHO and informs them of 'cases of pneumonia of unknown etiology' detected in Wuhan.

11 January - Chinese state media reported the first known death from an illness caused by the virus.

20 January - the Wuhan Municipal Health Commission reported 217 cases.

30th January - WHO declared the outbreak a PHEIC (Public Health Emergency of International Concern).

11 March – WHO declared COVID-19 a pandemic.

Eradication of the virus

Total eradication of SARS-CoV-2, globally is very unlikely to be possible unless there is some unexpected biological change in the virus. Elimination nationally (i.e. bringing the number of locally acquired cases to zero) may be possible transiently but is highly unlikely to be possible permanently. Though other countries appear to have eliminated the virus locally, it is still early in the pandemic and the virus is very likely to reappear in these countries.

Preparations for a potential second peak of COVID-19 infections

The Prime Minister has announced additional winter funding for the NHS of over £3 billion and extensive measures are already being put in place to ready the NHS for the risk of a second peak, and to relieve winter pressures on A+E and emergency care. This will allow

the NHS to continue using additional private hospital capacity and maintain the Nightingale hospitals until the end of March.

Testing capacity will be increased to half a million antigen tests a day by the end of October to bolster the NHS Test and Trace programme. Targeted testing programmes are already running for people at greatest risk of contact with the virus, such as weekly testing for care home staff, testing asymptomatic NHS staff, and working with employers such as Addison Lee to test their staff.

The Health Secretary has confirmed plans for the biggest flu vaccine programme in UK history.

We will also continue to fund the NHS's enhanced discharge arrangements to ensure patients can be quickly and safely discharged from NHS hospitals, and to free up beds for other patients.

The government has been developing scenarios for the winter to inform planning across government. In the coming months, we will assess what the UK can learn from other nations and carry out exercises to stress test our winter plans. In the meantime, the government continues to audit critical winter stockpiles of equipment and PPE.