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Trending article

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## COVID-19 Facts and Estimates

### Introduction

The novel SARS coronavirus epidemic is now a real pandemic threat as community acquired infections are on the rise in several places outside the original outbreak. Local epidemics have been reported in South Korea, Japan and Italy. Contained cases are even more widespread.

This article aims at providing some basic information on the COVID-19 outbreak for readers suffering from TLDR.

### What is SARS-CoV-2

First a few facts about terminology: COVID-19 (Coronavirus Disease 2019) is the clinical manifestation of an infection by the SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2). In media, these are often used interchangeably, and for most practical purposes, this distinction is somewhat redundant.

So, what is this infectious agent, SARS-CoV-2? It is a virus of the family *Coronaviridae*, a Baltimore classification Group IV ssRNA-virus - a virus whose genome consists of *positive sense* RNA the replication of which occurs by directly accessing the ribosomes of the host cell.

The virus family takes its name from its microscopic appearance: circular shape with prominent petal-like projections that resemble the solar *corona* (crown) or a halo.

The SARS-CoV-2 has genome size of 29 903 bases, typical of the range in *Coronaviridae*. It is thought to enter human cells via the ACE2-receptors (Angiotensin Converting Enzyme 2).

## What makes the SARS-CoV-2 different from others?

RNA-viri are notorious for their propensity to undergo *antigenic shifts*. Now, to understand why this is problematic, we need to take a quick look into viral genetics and evolution.

Viri evolve mainly through *antigenic drift* and *antigenic shift*. Drift represents the gradual evolution of the virus through accumulating mutations occurring naturally as the virus replicates. An overwhelmingly large part of these are actually harmful and do not produce any kind of advantage. Some of them may be neutral, and only a handful are actually beneficial. But since a virus has a very high rate of replication, this means the amount of mutations occurring is similarly high. This results in even those very few beneficial mutations surviving and amplifying due to evolutionary pressure - the virus must after all reproduce in a hostile environment of a multitude of immunological mechanisms trying to rid the host of it. As this process is stochastic in nature, this seldom results in dramatic changes in a virus, but may render potential hosts vulnerable to new infections when sufficient drift has occurred - a phenomenon typical of seasonal influenza.

What about *antigenic shift* then? This is where the unique properties of viri come into play (this is not to say that bacteria do not possess mechanisms that can result in similar outcomes, but that is beyond the scope of this article). An antigenic shift typically occurs when a virus crosses a species barrier. Many viri are adapted to a specific range of host and do not usually cross over easily - they thrive happily in their chosen range of hosts, being *endemic* in these *reservoirs*. Many of these viri are however phylogenetically related, and should that relation be close enough, a crossover can occur, resulting in a *zoonotic infection*.

As the genome of especially RNA-viri is naturally unstable due to lack of advanced proofreading mechanisms, there is a substantial chance the related viri may at some point of a concomitant infection come into contact with each other - i.e. happen to infect the very same cell. This is not too unlike a student party in Finland, where students engaging in a relationship may exchange pieces of their overalls to signify this. Quite similarly the different strains of related viri may exchange parts of their genomes with each other, resulting in a much more significant overall change (pun intended) to their characteristics.

Why is this shift so dangerous then? Firstly, this big shift results in the virus acquiring characteristics typical of its relative that has another natural reservoir. The immune system recognises threats mainly based on what they *look* like (in a biochemical sense), by learning and remembering. When a pathogen, say our virus here, acquires a whole new appearance, it will not be easy to recognise.

Secondly, since the host species are different, the virus may also acquire characteristics that greatly increase its *virulence*, i.e. its ability to cause infection. What may be of little significance to a species that has co-evolved with the endemic existence of the virus, can actually be really bad for another species with no such relationship.

When a virus having undergone such a shift enters a population, there will be no native immunity to it, which can result in a very high rate of infection, which further complicates things as infection is also the main mode of evolution. This is why zoonotic viri are so nasty and prone to cause dangerous epidemics that spread like wildfire.

There are a number of estimates regarding the phylogenetic origin of the SARS-CoV-2, the most accepted of which seem to be those claiming close resemblance to bat and pangolin strains of *Coronavirus*.

There have been claims that this strain may have been tampered with on purpose, but so far most of them have been unsubstantiated. So far, the overwhelming majority of evidence provides scant support for such claims.

## Why is this epidemic so widespread and why are governments resorting to such extreme measures to contain it?

We have seen many frightening reports from China in the recent weeks and seeing what draconian measures have been taken legitimately begs the question why.

Firstly, the Chinese government was unprepared. Since the novel virus emerged there, they had no heads up on the threat - so when the antigenic shift and epidemic potential of the novel virus were detected, it had already spread among the dense population. Thus, the government was already a few steps behind when the danger was recognised.

Secondly, simply because they can. China is a country with strict social control and a one-party system. No democratic debate is required to take action, nor have human rights ever been a top priority for the government. If the government estimates draconian measures are needed, so be it. They do have a very dense urban population to protect, after all, not to mention *face* to save from embarrassment.

This does not mean harsh measures are not possible, even probable outside of China. We have already seen several serious outbreaks elsewhere and there is no reason not to expect more. The advantage of others is that we have a heads up. While China could never expect to really contain the spread of infections, those governments with a heads up and a sufficiently evolved (and practiced) preparedness plan and the necessary infrastructure to support it will first and foremost attempt to stem the tide at their borders. Should this containment fail, as is the case in Italy, more drastic measures may be called for.

Why are the measures so extreme then? The primary cause is that we simply do not know enough about COVID-19 yet. While the Chinese government has so far been extraordinarily generous with information (at least to their own standards), there have been discrepancies in statistics and accusations of coverups. Since the Chinese government does have a rather sinister history of coverups and outright lies, it is easy to see why their data is viewed with a certain suspicion.

In a situation where information is lacking or deemed unreliable, it is usually better to err on the side of caution. We do not have accurate information on the two most defining characteristics of an epidemic infection: The *Basic reproduction number* and the *Case fatality rate*.

The basic reproductive rate, or  $R_0$ , for short, is a mathematical estimate of how many persons each infected person will in turn infect. This number is dependent on a number of disease characteristics, such as *mode of transmission* (Aerosol > droplet > fomites > faecal oral > direct contact), *incubation period* (time from infection to symptoms), actual time of infection (which may or may not be close to the symptomatic time), possible asymptomatic carriers etc. This makes estimating the  $R_0$  rather problematic and can usually be reliably estimated only post festum, when enough epidemiological data is available and can be processed with adequately advanced statistical models.

The case fatality rate simply means an average of how many of those infected die from the disease.

As of now, estimates of the  $R_0$  for SARS-CoV-2 range from a minuscule 1,4 to a high 6,6. For comparison, a  $R_0$  of 1,4 is similar to that of the Ebola virus, while 6,6 is closer to smallpox and polio. The higher estimates may be exaggerated, since the amount of infections on airliners does not seem to support the highest estimates.

Currently the case fatality rate is estimated as 2-3 %, which is comparable to that of seasonal influenza.

A further complicating factor, which warrants harsh containment measures is the obvious lack of an effective vaccine and the lack of information on the immunogenicity of the virus, i.e. whether recovery from an infection grants an effective immunity at all, and if so, for how long a time.

Although there have been some development efforts towards coronavirus vaccines, the very furthest developed one is still in its prototype stage with not even phase 1 studies completed. Even if this candidate were to prove efficacious, even optimistic estimates predict a full year needed to actually begin mass production and distribution.

### How bad is the situation?

For all intents and purposes, we should prepare for this epidemic to evolve into a pandemic. Containment has failed in a number of populous countries, some of which have highly evolved health service systems. The epidemic has still to hit Africa and India in full strength, which would expose large and underserved populations to infection and possibly result in a markedly higher case fatality rate due to lack of availability of specialised and intensive care.

At the time of writing this article, the epidemic in China appears to be subsiding, while new outbreaks are still gathering strength in Italy, Iran and South Korea.

According to the ECDC, the number of cases in Italy is now 400, of which 397 were locally acquired. The official total number of European cases was today 477, of which 425 were locally acquired.

For comparison, the number of new positively tested seasonal influenza cases in Europe in week 7 was around 1300.

The perhaps most dangerous aspect of the coronavirus epidemic is that it is coinciding with the seasonal influenza epidemic and thus putting a potentially equal, additional strain on the healthcare system. The intense efforts to contain the spread of the epidemic also have their obvious implications for the economy, with the European Commission estimating losses of up to 30 billion dollars for the aviation and tourism industry alone.

### What can I do?

Keep calm and carry on. With infectivity and mortality similar to the seasonal flu (with the exception of the lack of a vaccine), the SARS-CoV-2 is hardly a doomsday plague, but ordinary precautions are naturally in order.

These include:

- Monitoring the information given by the authorities - they exist for a reason, one of the most important of which is protecting the population from health threats.
- Washing your hands regularly and avoiding sneezing and coughing at people (as if these weren't obvious - they are, are they?)
- Avoiding unnecessary crowds - do you really need to go to that football game?
- If there is an outbreak in your area, consider teleworking.
- Avoiding travel to epidemic areas - obviously. Monitor the travel information of your government's foreign ministry.

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#### What not to do:

- Panic buying. Although a widespread epidemic may certainly create all kinds of disruption, it is highly unlikely that stocks of food and other necessities would run out. While stocks may be affected locally if a substantial number of people get sick, this is bound to be temporary and more affected by disturbances in logistics than stocks actually running out. Panic buying only exacerbates those disturbances and puts an additional strain on the supply and logistics system and may encourage price gouging.
- Show up for work/school/whatever sick. You should know better. Follow the instructions of your local health authorities. Do not expose others. This applies to any kind of communicable disease.
- Break any orders issued by the authorities. They were probably issued for a good reason and going against them puts both yourself and people around you in danger. Forget the football game, the costs to society could be a thousand-fold more than one cancelled game.
- Hoard a stock of masks and gloves. Firstly, for a mask to actually protect *yourself* it should be of at least grade FFP3 *and* worn correctly - and most people do now know how to. This may only serve to cause a false sense of safety while actually having little effect at all. As for gloves, you'll probably only need them if you are health care professional, and if you are, you probably don't need to worry about protective gear anyway, as they will be issued by your employer. What you *can* do, is wear any kind of mask *if* you have symptoms of a respiratory infection. While masks are rather bad at protecting healthy individuals from infection, they *do* prevent the spread of your own infectious particles expelled by coughing and sneezing.
- Fill your sauna with sugar. You've probably got better use for it anyway.

#### Bottom line and final remarks

This epidemic came at a nasty time and we have not seen the worst of it. Expect *some* disruption but remember that *your best defence is common sense* and good hygiene. We all share a responsibility to avoid panic, dis- and misinformation. Our lives may be affected, but egotistic and irresponsible behaviour has certainly better times than in the middle of a would-be pandemic.

#### Update 3.3.2020

The number of cases continues to grow in both Europe and elsewhere. As of today, the ECDC reports a total number of 2495 cases in Europe, 1835 of which are in Italy. The total number of fatalities has now reached 56, 52 of which occurred in Italy.

Meanwhile, the seasonal influenza epidemic appears to be subsiding, with about 900 new cases reported last week. The total number of influenza cases for this season, however, has been 89068 (as of 2.3.2020) with 3046 fatalities.

There still seems to be a significant threat of COVID-19 coinciding with the seasonal influenza epidemic putting an additional strain on the healthcare system.

Containment failure seems imminent in France, Spain, France and Germany.

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