# Coronavirus: Why it's so deadly in Italy

Demographics and why they are a warning to other countries

Andreas Backhaus
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As we study the numbers on the coronavirus cases and the deaths related to COVID-19, a similar question comes up again and again:

> ## Why is the coronavirus causing so many more deaths in Italy than in other countries?

This question relates both to the absolute number of deaths , which is currently exceeded only in China, and to the case fatality rate, which has risen to 6.6% and exceeds any other country in the world.

To make sure we are all on the same page: The **case fatality rate of COVID-19** is the number of confirmed deaths due to COVID-19 divided by the total number of confirmed cases of infections with the coronavirus SARS-CoV-2. The case fatality rate (CFR) should not be confused with the mortality rate or death rate (while it often *is* confused with them), which is simply the total number of deaths that occur during a specific time frame divided by the number of the total population at approximately the same time. Currently, we are more interested in the CFR because we see the number of cases growing and we want to know how many of these diagnosed cases will result in the death of the patients. The CFR is currently at 0.066 or 6.6% in Italy, 2.1% in France, 0.8% in South Korea, and 0.2% in Germany, according to the latest data collected by worldometer. What explains these immense differences?
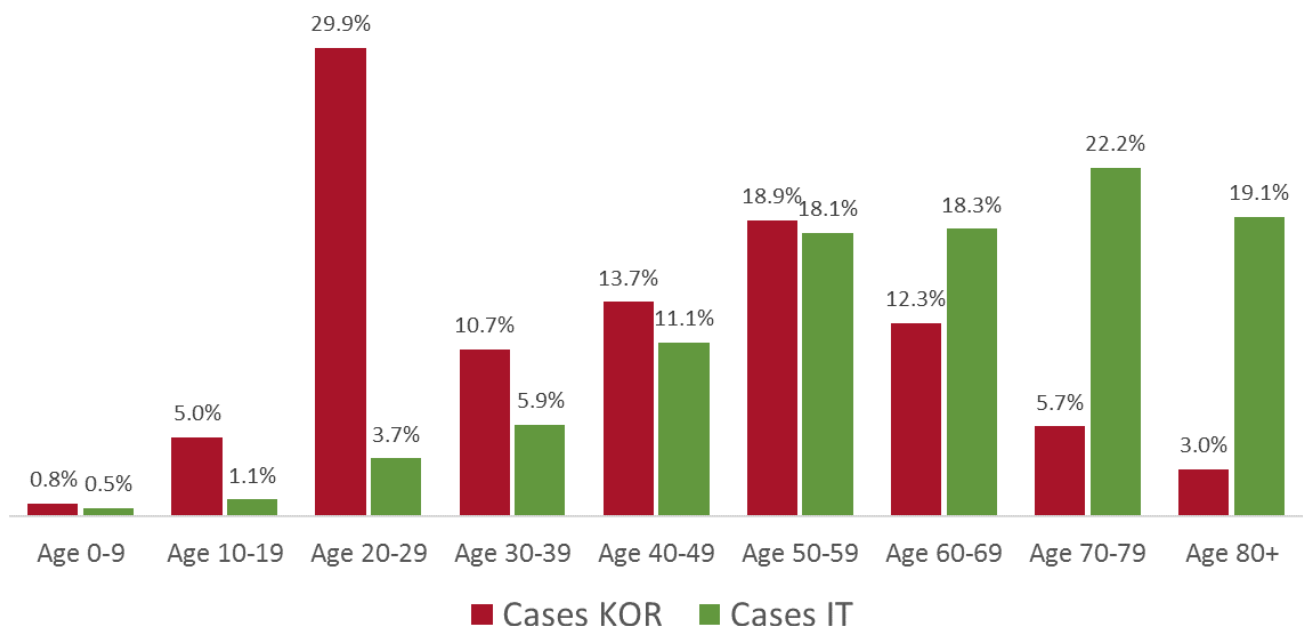
## The cases behind the case fatality rate

Let us assume every country is equally capable of counting the numerator of the CFR, the fatalities due to COVID-19, and will report them accurately; an assumption that is tolerable if we focus on non-authoritarian high-income countries. What do we then need to know about the denominator, the confirmed cases? The strongest predictors of

fatality due to COVID-19 are age and pre-existing conditions of the infected. The number of pre-existing conditions is positively correlated with age, so let us for simplicity only look at the age of the confirmed cases. Clearly, because age is so predictive of death by COVID-19, comparing the case fatality rates across countries only makes sense if the underlying cases of coronavirus have approximately the same age across countries.

What do we know about the age of the people that have been found to be infected with the coronavirus? This information is not easy to find, but it has been popping up in reports and newspapers from the various countries over the past days. The diagrams and figures reported in the following are based on statistics reported by the Korean news agency news1 (screenshot) and the Italian daily newspaper Corriere della Sera.

Grouping the age in ten-year-intervals and comparing the percentage shares of cases that fall into each age group reveals a striking dissimilarity between South Korea (red bars) and Italy (green bars): Recently, **3%** of all confirmed cases in South Korea were at least 80 years old. At about the same time, **19.1%** of all confirmed cases in Italy were at least 80 years old.
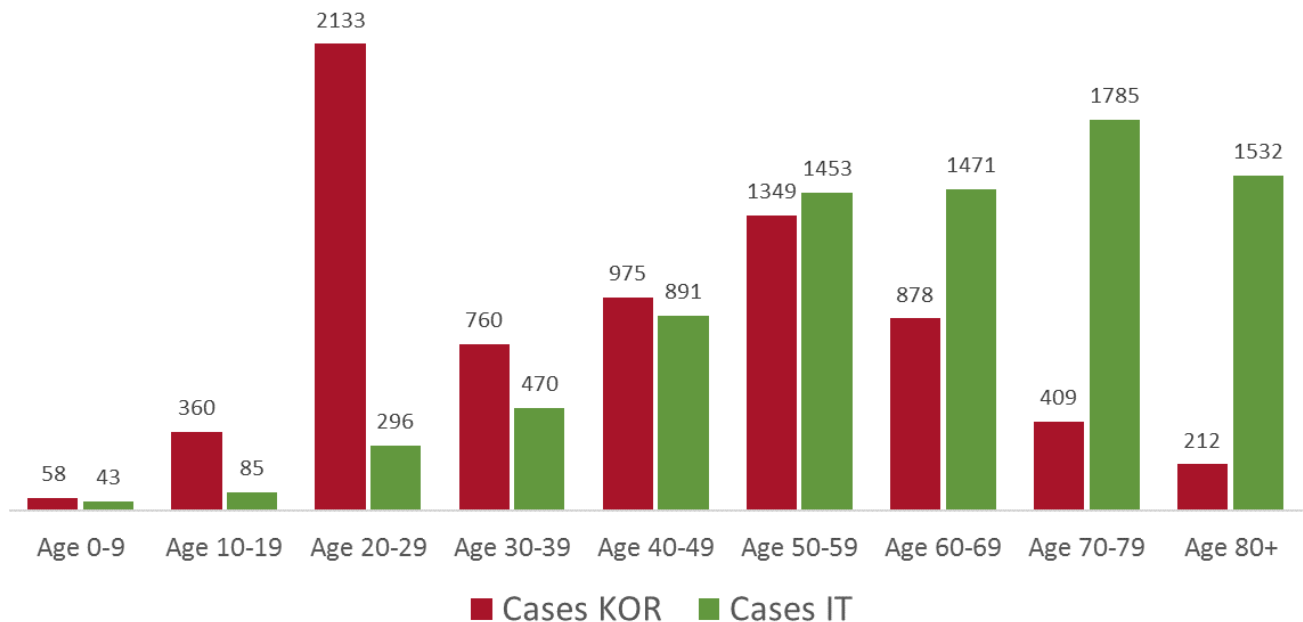
### Coronavirus cases (%) in South Korea and Italy by age groups



This enormous difference occurred while the absolute numbers of confirmed cases overall were similar in the two countries (8,036 in Italy vs 7,134 in South Korea). Consequently, Italy's healthcare and hospital system had to take care of a much higher

number of infected older patients than the South Korean one — patients that need more intensive care and that are simultaneously more likely to pass away.

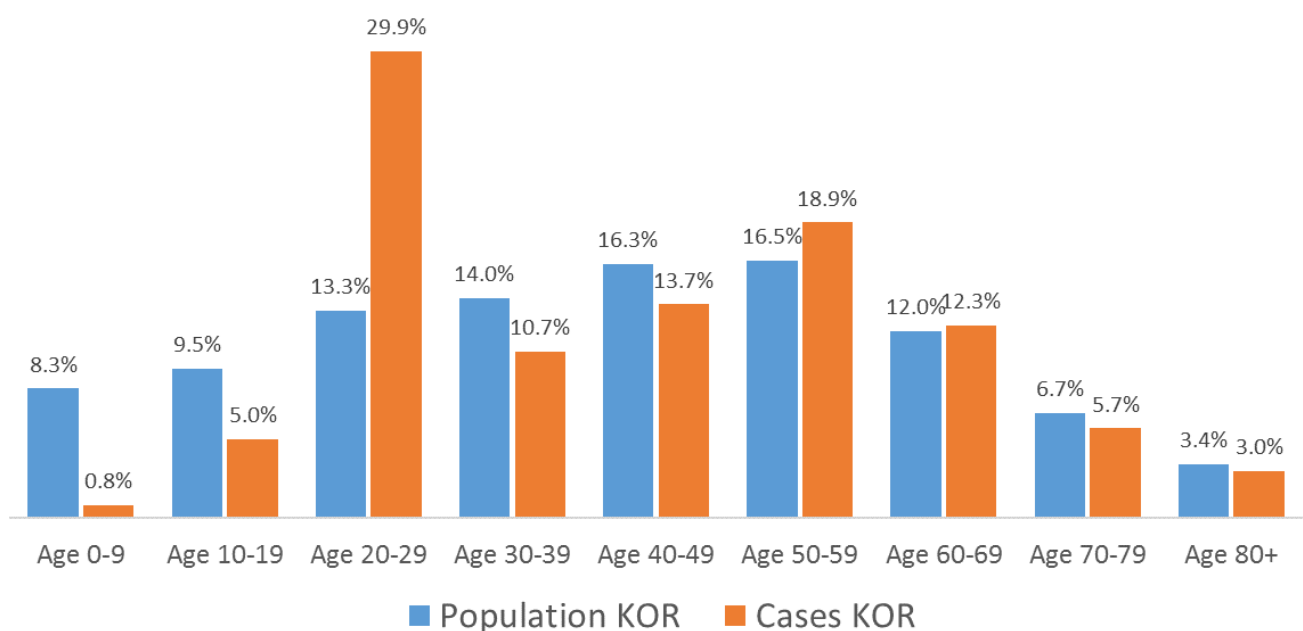### Coronavirus cases in South Korea and Italy by age groups



A clear implication is that the Italian CFR is not comparable to the Korean CFR — the people infected with the coronavirus that enter the Italian CFR are much older than those that enter the Korean CFR, and as older people are much more likely to die of COVID-19, they push the Italian CFR upwards. Another implication is that explaining the different CFRs with differences in the healthcare and hospital systems between Italy and South Korea might be premature — in the current coronavirus crisis, South Korea's hospitals and intensive care units have never been tested to the extent that Italy's currently are.

## Which CFR is unusual — Italy's or South Korea's?

An obvious question that follows is: Why do these age distributions look so different in the two countries? Many people have already pointed out that Italy has an older population than South Korea. The higher Italian CFR might therefore reflect a higher likelihood that an old person becomes infected with the coronavirus simply because there are more old people among the Italian population. We can easily check the plausibility of this argument by comparing the age structure of the coronavirus cases with the age structure of the total population for both countries. The population data are from the United Nations' World Population Prospect 2019.
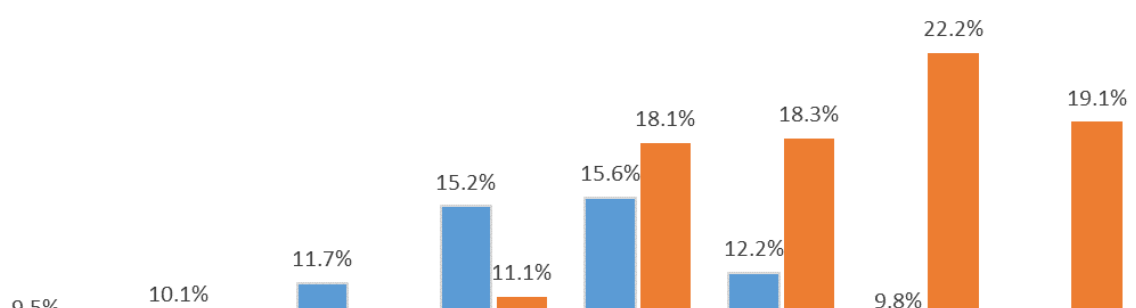
In South Korea, the age structure of the coronavirus cases is remarkably similar to the age structure of the population, in particular for the older age groups. The 20–29-year-olds are still hugely overrepresented among the confirmed cases relative to their population share, but their surplus is balanced by the underrepresentation of cases among the 0–9- and 10–19-year-olds. These three youngest age groups face a very low risk of dying from COVID-19. The South Korean CFR is hence not depressed or exaggerated by an under- or overrepresentation of older Koreans among the confirmed cases.
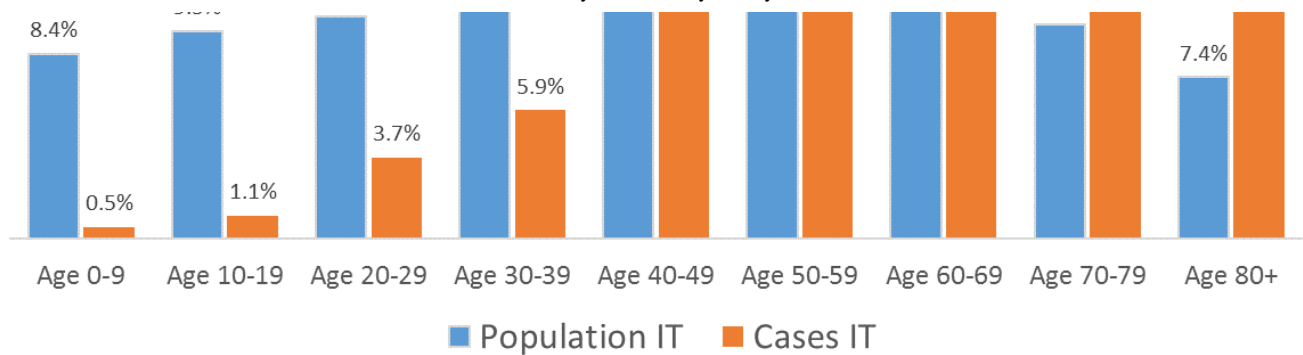
**Population and Coronavirus cases in South Korea by age groups**



The same is not true for Italy: The share of confirmed cases at age 70–79 exceeds the population share of this age group by more than a factor of two. Among those aged 80 and more, the case share is almost three times as high as the population share. By contrast, young people and hence low-fatality-risk people are visibly underrepresented among the confirmed cases.

**Population and Coronavirus cases in Italy by age groups**

Hence, the question remains why the age distribution of cases is shaped so differently in Italy compared to South Korea. It has also been pointed out that the testing procedures for coronavirus in the countries are very different — Italy has predominantly been testing people with symptoms of a coronavirus infection, while South Korea has been testing basically everyone since the outbreak had become apparent. Consequently, South Korea has detected more asymptomatic, but positive cases of coronavirus than Italy, in particular among young people.
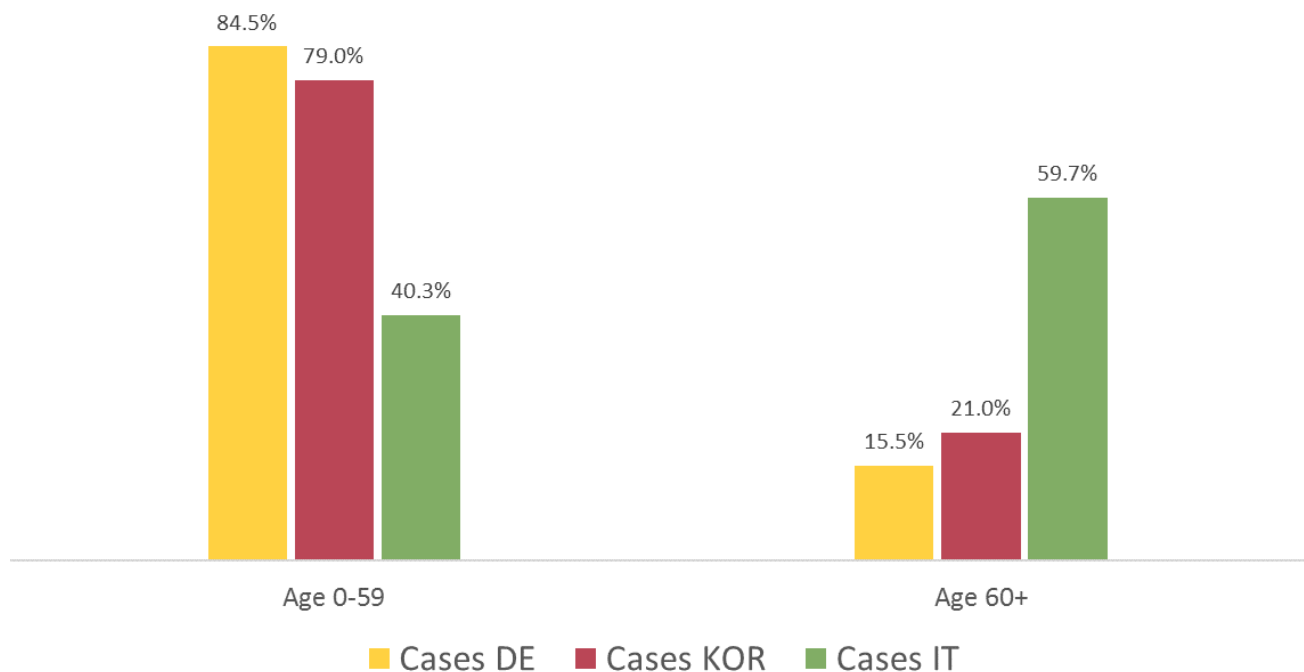
A complementary reason is that the Korean outbreak took place mainly among followers of the Shincheonji megachurch/sect in and around the city of Daegu. Possibly, many followers of this movement are of relatively young age, explaining the unusual spike of cases among the 20–29-year-olds once testing intensified around this group. This might have also prevented the virus from spreading extensively among the Korean elderly so far. With regard to Italy, we do not know who spread the virus among the old population of the North — but the surprisingly high number of tourists that have been diagnosed with coronavirus after returning from trips to Northern Italy suggests that the unnoticed and asymptomatic spread of the virus has probably been going on there for quite some time, building up to then ravage the elderly.

The bottom line is that the coronavirus hit Italy and South Korea very differently in terms of age at around the same time and the same level of the outbreak — at least the level that we noticed in terms of confirmed cases — thereby causing a much higher number of deaths in Italy. An implication is that simply tracing the number of confirmed coronavirus cases by country over time, as many graphs and website currently do, is not telling the full story. The raw number of cases is a rather poor predictor of deaths by COVID-19, at least in the short-run. If the virus spreads predominantly among young people, as appears to have been the case in South Korea, there is no immediate risk of collapse to the hospitals. However, if it spreads to the old population, as in Italy, collapse is looming; and it might be a matter of days. When (not if) this happens is another factor that is hard to predict, as some efforts are underway.
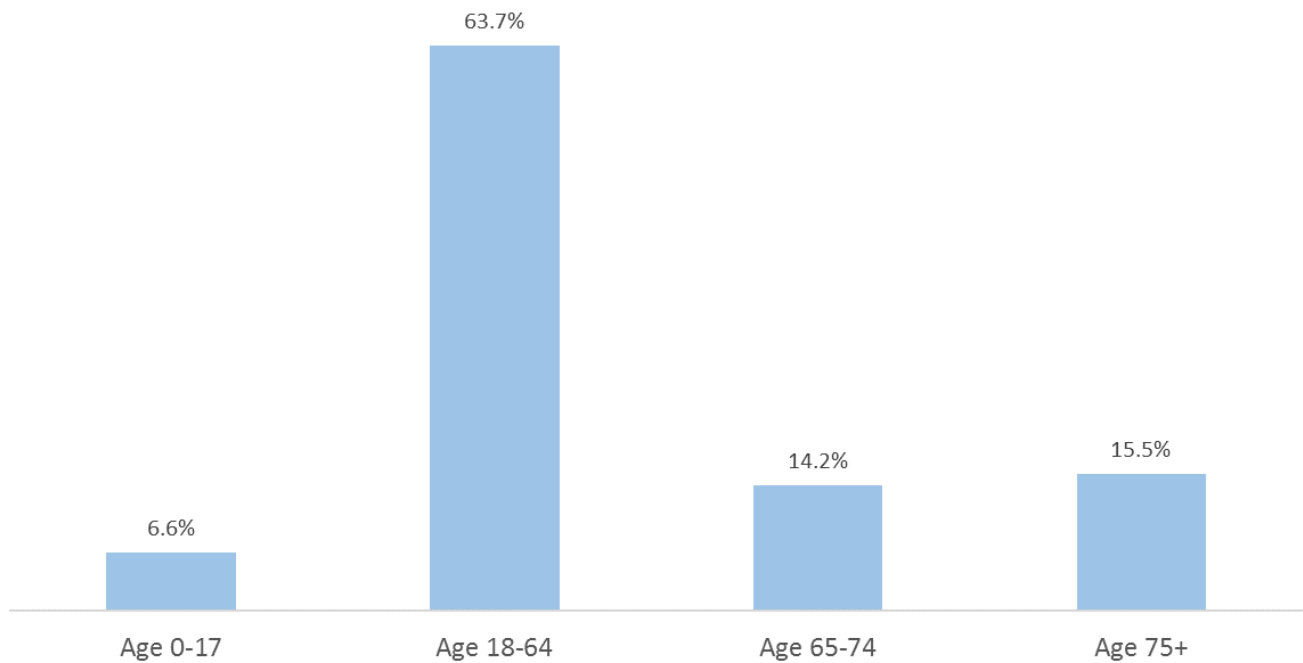
# Looking beyond Italy and South Korea

From these two rather polar-opposite cases of Italy and South Korea, what can be learned for other countries? Age aggregates for a subsample of the German confirmed cases of coronavirus have been published by the Robert Koch Institute, which is a German federal government agency responsible for disease control and prevention. Let us assume the subsample is representative. The age aggregates are not the same as in the Italian and Korean data, but cases can still be allocated to two groups: those younger than 60 years and those 60 years or older.

### Coronavirus cases (%) in Germany, South Korea, and Italy by age group



Based on this comparison, Germany has even been a bit "luckier" than South Korea for now, as the coronavirus apparently has been spreading among the younger German population. This finding could be reflected in the currently very low German CFR of 0.2%. The concentration of cases of coronavirus among its younger population might have provided Germany with a bit more time to prepare itself for the moment when the number of infected will rise among its elderly. We have to keep in mind that 29% of Germany's population is at least 60 years old, according to the Federal Statistical Office.

The French National Health Agency has also published age aggregates of the confirmed cases, but the aggregates are not compatible with those of the other countries. Looking at the French data alone suggests that France represents a scenario somewhere between the Korean and the Italian one, as close to 30% of the French confirmed cases are at least 65 years old.

**Coronavirus cases (%) in France by age group**



Again, this pattern could be reflected in the current French CFR of 2.1%, which is ten times higher than the German one, but only 2.5 times higher than the Korean one. In absolute terms, France has already had almost as many deaths as South Korea due to COVID-19, and we should not expect the French death toll to stabilize soon. These are still very few data points and unfortunately, the availability of information on the age of confirmed cases will likely decrease as the case numbers grow and the situation might escalate in more countries.

## South Korea provides a useful estimate of the CFR — but no guarantee

We can learn something more that is potentially very useful from the Korean statistics. We have seen above that the age distribution of the confirmed cases corresponds rather closely to the age distribution of the overall population in South Korea if we subsume everyone below age 30 into one group where almost nobody dies from COVID-19. At the time of reporting, 50 of the confirmed 7,134 people infected with the coronavirus had died, implying an aggregate CFR of 0.7%. Since then, the Korean CFR has been creeping up to 0.89%. Hence, 1% seems to be a reasonable estimate of the case fatality rate in a high-income country (!) in the absence of any major failures of the hospital and care system (!). This 1% CFR estimate is close to what Dr. Jeremy Faust has been suggesting based on the *Diamond Princess* cruise ship case.

Clearly, one of the worst conclusions that could be drawn from this is that the various case fatality rates across countries will settle down at 1% eventually all by themselves. They won't. Due to the hospital system becoming overwhelmed in Northern Italy, we already have excess mortality there that cannot be undone. Germany, with its low share of individuals infected with the coronavirus at higher age, might have gained some valuable time, but this is just a time lag, it is not a restraint to the coronavirus spreading further to the elderly soon. The relatively high and quickly growing case fatality rates in France and especially in Spain suggest that the virus has already infected a large number of older and vulnerable citizens in these countries. Regarding the US, we are still completely in the dark. Everything that is being said about the need for social distancing and in particular the protection of the elderly remains ever so true.

**Update 1 (minor):** I corrected a typo: It's *"numerator"* and not *"nominator"*, of course. Thanks to Wei-Hwa Huang for pointing me to it.

**Update 2 (attribution):** Graphs from this story that had been created by me have been copy-pasted and circulated widely without attribution. Examples of viral tweets: Here (Mark then added the source below), here by Dr. Eric Feigl-Ding, here by Dr. Abdul El-Sayed, and countless others. I believe nobody shared them intentionally without source; it's just how it went. I created these graphs for the purpose of providing information and I am pleased by how well they have been received. However, content creation, journalism, and science all rely on proper attribution. Please refer to this story as the source of the graphs once you see them being circulated without attribution. Thank you!

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