Understanding Elementary Statistics on COVID-19: What do they measure? & How to use them?

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The Statistics

1) IR= Infection rate = total # of Covid-19 cases per million persons in the population

IR measures how many persons are contracting the virus relative to its total population at a point in time.

Usefulness, comparing any two countries (or areas) at similar times after identification of the first few cases. For instance, 30 days after the first case. It measures the rate of spread of the virus at a given distance in time from its arrival.

2) DR= Death Rate = total number of COVID-19 deaths per million persons in the population.

DR measures how many people are dying from the virus relative to a country's total population at a point in time.

Usefulness, comparing most damaging unsuccessful outcome between countries at any point in time.

3) TR = # of COVID -19 tests performed per million persons in the population

TR measures the number of COVID-19 tests performed at any point in time relative to the number of persons in the population.

Usefulness, not much by itself. Essential in conjunction with the infection rate to generate.

4) POR = Positivity Rate = IR/TR= total # of COVID-19 cases relative to the number of tests given.

POR measure how fast COVID-19 is spreading in a country at a point in time, especially accurate when multiple tests to same person excluded from TR. It is still useful as an estimate even if multiple tests to same person not excluded, because we know it biases positivity rate downwards.

5) HSPR = Health System Performance Rate= DR/IR

HSPR measures the number of deaths for any given infection rate in an area at a point in time.

Usefulness, despite lags between deaths and infection, it gives an estimate of how a health system is performing in preventing the most unsuccessful outcome for a given infection rate in an area at a point in time that could be useful if other things were indeed equal. A minimum requirement for its usefulness is availability of positivity rate in the comparison, because the performance of health systems can vary dramatically between normal times and crisis times, i.e., depending on level of virus transmission going on at any point in time. Also, it is useful if age distribution of areas compared are similar, i.e., with respect to the most vulnerable residents, for example males over 65.

Illustrative Example

Below I provide an illustrative example with five countries: The U.S., the UK, Australia, Canada and New Zealand. That is, the UK and four of its former colonies. It generates two useful comparisons.

Country*	IR	DR	TR	POR = IR/TR	HSPR= DR/IR	% Male>65^
USA	14,923	486	186,785	.080	.033	15
UK	4,523	683	253,391	.018	.151	17
Canada	3,125	237	112,157	.028	.076	16
Australia	762	10	177,905	.004	.013	15
New Zealand	314	4	95,542	.003	.013	15

*All pandemic country data taken from Worldometer, August 5 2020.

^ World Bank data for 2019, provided by Julio Betancourt

Comparison 1. USA versus UK

1) Positivity rate > 5 percent → virus transmission out of control in US relative to UK; i.e., virus spreading at least four times faster in the U.S.
2) Far more testing in the UK than in the U.S., i.e. 26 % more testing 'per capita' in the UK. Not great news for the U.S. testing system.
3) Death rate worse in the UK than in the U.S., i.e., 29% higher in the UK
4) Health system performance is five times worse in the UK, despite less health system pressure due to much lower transmission rate in UK. Not great news for the UK's health system.

This comparison is in some sense the most applicable because both countries started reacting to the pandemic as a crisis at the same time. Namely, when on March 26 the Ferguson simulation study predicted 500 K deaths for the UK and 2.200 K for the U.S if nothing was done, i.e., a death rate of o.7% of the population in each country. That got Boris Johnson and Donald Trump out of their do nothing attitudes. Johnson figured out what to do with the testing; Trump, or Kushner or both did not. The performance of a health system, however, depends on A) national system characteristics, B) the accumulated human capital of doctors, nurses, other hospital staff and first responders and C) their actual behavior during crisis and non-crisis situations. UK's outcomes would have been far more catastrophic by now if it had not controlled the virus spread so much better than the U.S. In the future, U.S. outcomes might be far more catastrophic if real testing rate does not improve, many or most of the doctors, nurses, hospital staff and first respondents that died have no replacements, or their replacements fail to replicate their heroic behavior.

Comparison 2. USA versus other former British colonies or Commonwealth countries (Canada, Australia and New Zealand).

1) Positivity rate < 1 percent → virus spread is under control in a country. In Australia (New Zealand) the virus is spreading 20 (about 26) times slower than in the U.S. In Canada the virus is spreading at a rate close to 3 times slower than the U.S and at (just above) 7(9) times faster than Australia (New Zealand) but higher than the decreasing transmission threshold of 1%.
2) There is far more testing in Australia than in New Zealand but the transmission outcome is similar although 33% faster than the very low .003 in New Zealand. Hence, New Zealand must be doing some things that substitute for testing in suppressing spread. Perhaps leadership support for mask wearing and social distancing, better contract tracing for a given level of

testing, or stricter enforcement, or being an island? Canada, however, is testing much less than Australia, i.e., (58% less) although more than New Zealand (about 17% more). It has a 7 times faster rate of spread of the virus than Australia. Thus, it must not be relying on the substitutes that New Zealand is using. All three of them are testing less than the U.S. Australia, which comes closest, is testing just 4.7% less than the U.S.

3) Canada's death rate is much lower than the US (about 51% less) but much higher than Australia's and New Zealand's (over 23 times and over 59 times, respectively).
4) Canada's health system performance is worse than the US (about 2.3 times worse) despite its lower death rates and positivity rates, which raises questions about why the bad Canadian health system performance during the pandemic. Australia and New Zealand, on the other hand, have controlled virus transmission at very low levels, as evidenced by their positivity rates. Thus, their health systems performed much better than the US, UK or Canada by a wide margin, i.e., 2.5, 3.3 and 5.8 times better, respectively.

This second comparison's main lesson is that there is no substitute to bringing the virus under control by lowering the transmission rate substantially below one as early as possible, regardless of the quality of your health system, and keeping it that way.

Basic Conceptual Implications.

1. The testing rate has no deterministic impact on the infection rate. Moreover, the testing rate by itself is unlikely to play a causal role on the infection rate in a statistical sense.
2. Substantial prevention of infection transmission, regardless of specific strategy, generates far better outcomes on death rates and health system performance than any alternative strategies that allow for positivity rates above unity, let alone above the out of control 5%.

Practical Implications.

1. The data source has these data for over 100 countries. Hence, the readers can pursue similar comparisons for any subset of those countries they find interesting. An extended table with additional countries is included at the end as an example.
2. Similarly, the data set has these data for all 50 U.S. states and DC. Hence, the readers can engage in these comparisons across states they find interesting. Nevertheless, analysis of lower level jurisdictions, for example counties in the U.S., would require other data sets.
3. The data presented here are measures at a point in time, August 5 2020. Hence, readers could look at worldometer on Saturday September 5th 2020, the Saturday before Labor day, and see how the subset of countries or U.S. states that interest them have performed over the next month, which is just before some school systems open or after they have done so for a few weeks.
4. Finally, a similar experiment is performable on Tuesday October 6 2020, after schools have been in operation for several weeks almost everywhere, and four weeks before U.S. elections.

These practical suggestions are easily accessible for inquisitive students of all ages. All you need is to click and copy for the first three columns of figures in the data link above and to be able to divide column1 by column 3 to create column 4 and column 2 by column 1 to create column 5. Suitable for ages from around 10 – 12 years old to any senior without major cognitive problems. Enjoy.

*Exchanges with Beatriz Hardy, Julio Betancourt, Allan Drazen and especially Luis R. Luis have substantially increased my confidence in the robustness and educational usefulness of the exercises discussed here. Their comments and insights, among other things, led me to first gather and later include the data below. I am grateful for these comments. Any remaining issues that may arise with the data and analysis above or with what you may find in the data below are the sole responsibility of the author.

Extended Data. *	IR	DR	TR	POR= IR/TR	HSPR= DR/IR	% Male>65^
Spain	7,546	610	151,087	.050	.081	17
Italy	4,116	582	116,471	.035	.141	21
France	2,972	464	45,680	.065	.156	18
Germany	2,549	110	102,454	.025	.043	19
Denmark	2,448	106	281,264	.009	.043	19
Japan	315	8	6,937	.045	.025	25
South Korea	282	6	31,170	.009	.021	13
China	59	3	62,184	.001	.051	10
Cuba	241	8	24,883	.010	.033	14
Jamaica**	339	4	42,964	.008	.012	9
Brazil	13,246	453	62,665	.211	.034	8
Chile	19,064	512	90,835	.210	.027	10
El Salvador **	3,147	85	40,238	.078	.027	8

**pandemic country data taken from Worldometer, August 8 2020.