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. Finally, it is not a measure of quality of the health system by itself because performance depends on the behavior of the population which the health system doesn't control, e.g., social distancing. I am grateful to Tanjim Hossain for a clever illustration of this point.

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 cross-country comparisons and one overtime comparison August/September for each.

Country*	POR (Aug.)	POR (Sep.)	HSPR (Aug.)	HSPR (Sep.)	% Male>65^
USA	.080	.075	.033	.030	15
UK	.018	.019	.151	.122	17
Canada	.028	.023	.076	.070	16
Australia	.004	.004	.013	.028	15
New Zealand	.003	.002	.013	.014	15

*All September underlying pandemic country data taken from Worldometer, September 4 2020; August data from same source on August 5

^ World Bank data for 2019, provided by Julio Betancourt

Comparison 1. USA versus UK in September

1) Positivity rate > 5 percent → virus transmission out of control in US relative to UK; i.e., virus spreading about four times faster in the U.S. in both periods
2) More testing per capita in the UK than in the U.S. in both periods although gap closed considerably. (not shown in table data). Still not great news for the U.S. testing system.
3) Death rate worse in the UK than in the U.S. (not shown in Table data)
4) Health system performance in the UK improved significantly (24%) although still much worse than in the US, which also improved (11%), 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 C) their actual behavior during crisis and non-crisis situations and D) the population's behavior. 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 continue to 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 and/or the population does not modify its behavior.

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

1) Positivity rate < 1 percent → virus spread is under control in a country. In Australia & New Zealand the virus spread is under control; in the US and Canada spread is slowing but not under control in either period (slowing faster in Canada). In New Zealand the virus spread continues to slow by September but not in Australia.
2) There is far more testing in Australia than in New Zealand but the transmission outcome is similar although faster than the very low .002 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 in both periods and 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 US on per capita terms (not show in the table).
3) Canada's death rate is much lower than the US (at least 50% less in both periods) but much higher than Australia's and New Zealand's in both periods (at least over 20 and 50 times, respectively).
4) Canada's health system performance is worse than the US (at least two times worse in both periods) despite its lower death rates and positivity rates, which raises questions about the reasons for the Canadian health system performance during the pandemic. While Australia and New Zealand, on the other hand, have controlled virus transmission at very low levels, as evidenced by their positivity rates, their health systems performance diverge in September. New Zealand continues to perform much better than the US, Canada, the UK and Australia. It continues to be at least twice as good as the other four countries in preventing deaths per infection. On the other hand, Australia drops from being as good as New Zealand at the beginning of August to just 6.7% better than the US at the beginning of September.

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 and keeping it there. Indeed, not doing so can affect the performance of your health system in dealing with the virus even at very low transmission rates.

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.

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.
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 US states they find interesting. Nevertheless, analysis of lower level jurisdictions, for example counties in the U.S., would require other data sets.
3. The summary data presented here are measures at two points in time, August 5 2020, and September 4th 2020. Hence, readers could look at worldometer on Saturday, Ocotber 3rd 2020 , and see how the subset of countries or U.S. states that interest them have performed over the

next month, which is just after labor day and many school systems and Universities are open in some form or another.

4. Finally, a similar experiment is performable on Sunday, November 1st 2020, just before U.S. elections.

These practical suggestions are easily accessible for inquisitive students of all ages. First, google the Worldometer data set, copy the data for infection rates per capita (IR), death rates per capita (DR) and testing per capita (TR). Second, calculate POR = (IR/ TR) and HSPR = (DR/IR). Third, you can insert the results for whatever day or month you want in the tables in here. 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, Tanjim Hossain and Luis R. Luis have substantially increased my confidence in the robustness and educational usefulness of the exercises discussed here. I am grateful for these comments. Any remaining issues that may arise with the data and analysis above are the sole responsibility of the author.

Extended Data!	POR (Aug.)	POR (Sep.)	HSPR (Aug.)	HSPR (Sep.)	% Male>65^
Selected European					
Spain	.050	.053	.081	.060	17
Italy	.035	.031	.141	.130	21
France	.065	.040	.156	.102	18
Germany	.025	.020	.043	.038	19
Denmark	.009	.007	.043	.036	19
Selected Other					
Japan	.045	.045	.025	.018	25
South Korea	.009	.010	.021	.015	13
China	.001	.001	.051	.051	10
Cuba	.010	.010	.033	.024	14
Jamaica	.008	.048	.012	.010	9
Selected Latin American					
Brazil	.211	.281	.034	.031	8
Chile	.210	.166	.027	.027	10
El Salvador	.078	.080	.027	.029	8

! Underlying pandemic country data taken from Worldometer (8/05/2020; 9/04/2020).