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# Case-fatality rate of COVID-19 is declining since May 2020

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# Background

- On March 11, 2020, the WHO declared the COVID-19 outbreak as a global pandemic.
- As of August 31st, 2020, there are over 25 million identified cases and 800,000 deaths of COVID-19 worldwide in 213 countries and territories.
- The reported case fatality rate (rCFR) of COVID-19, which is defined as the risk of deaths among the reported infected cases, varies so greatly in different countries.
- For example, the rCFR of COVID-19 varies from 26% in Yemen to 0.1% in Singapore and Qatar.

# Objective

## The objective of this study:

- To understand the variation of reported CFR of COVID-19 based on reported COVID-19 cases and deaths data globally over time.
- To identify variables that explain these differences in the rCFR of COVID-19 pandemic in different situations.

## Methodology (Data Collection)

- We collect daily COVID-19 cases and deaths data from the WHO's daily situation reports from January 1 to August 31, 2020 (Epidemiological week 1-35).
- Further, we collected explanatory variables for each country including population density, gross domestic product (GDP), worldwide governance indicator (WGI), Global Health Security Index (GHSI), the prevalence of obesity, the percentage of people aged 65 and above.

## Methodology (Statistical analysis)

- We divided the dataset into two half one until rCFR reach peak, 17<sup>th</sup> week (22-28 April 2020) and termed as “before peak rCFR” or simply as “pre-peak period” and another with 18<sup>th</sup> – 35<sup>th</sup> week (August 25-31, 2020) and termed as “after peak rCFR period” or simply as “post-peak period”.
- As the trend of rCFR in both periods is different, we ran our model separately for each dataset.

## Methodology (Statistical analysis)

- As the outcome variable (rCFR) varies in an interval of 0 or 1, we used beta regression models to investigate the association between possible explanatory variables and the mortality rate.
- The exponential of the parameter of the beta regression is known as incidence rate ratios (IRRs) which are the contribution of the variable in rCFR of COVID-19. We reported IRRs with 95% confidence intervals (CIs).

# Methodology (Statistical analysis)

## Trend analysis:

We performed an autoregressive integrated moving average (ARIMA) and automatic forecasting time-series model to predict 10-days CFR and compared with the rCFR data.

## Beta regression model:

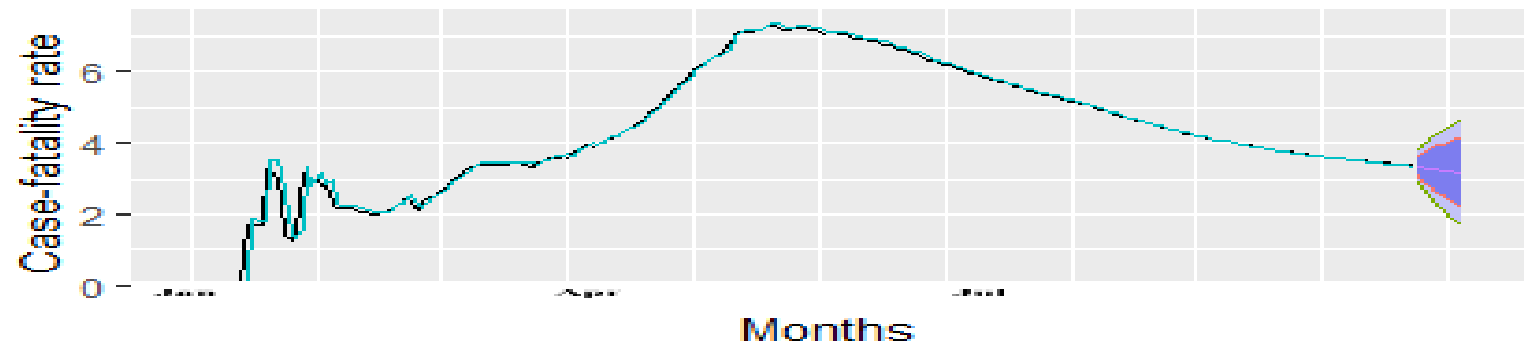
$\text{rCFR} \sim \text{Population density} + 65 \text{ years or above age} + \text{Obesity} + \text{Total test per thousand} + \text{GHSI} + \text{GDP} + \text{WGI}$



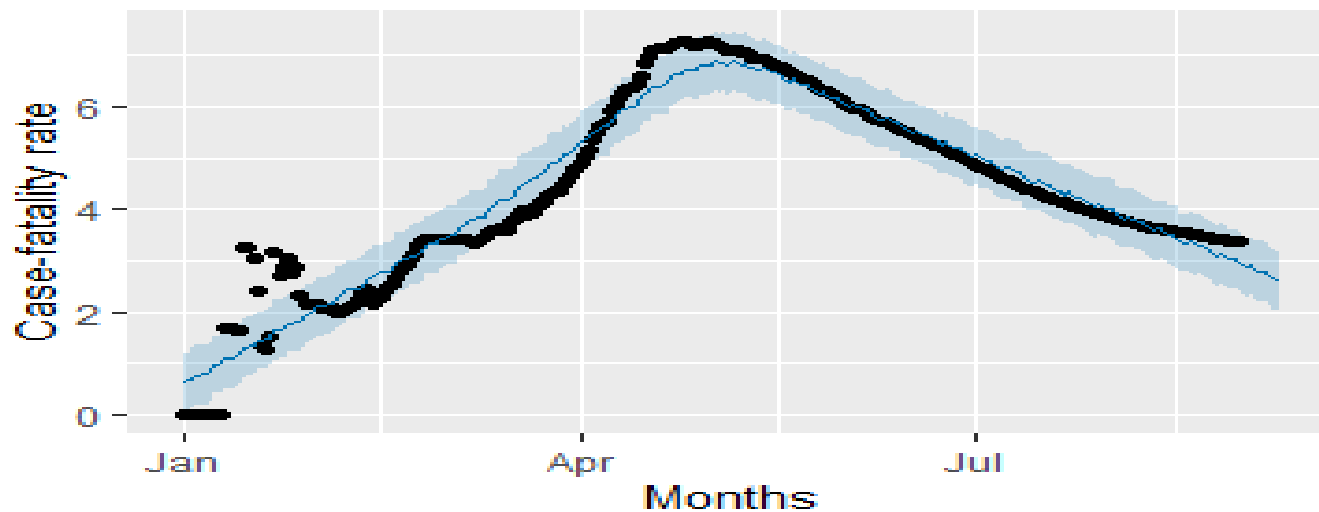
## Results (Trend analysis)

- The weekly global cumulative COVID-19 rCFR reached the peak at 7.23 during 17<sup>th</sup> Epidemiological week (April 22-28, 2020).
- We found a positive and increasing trend for global daily rCFR of COVID-19 until 17<sup>th</sup> Epidemiological week and then a strong declining trend up until 35<sup>th</sup> week at 3.4 (August 25-31, 2020) in ARIMA and automatic forecasting time-series model (Fig 1).

Fig 1: Observed and predicted daily worldwide cumulative rCFR ARIMA model and Prophet model



Observed data — 80% — 95% — Fitted — Forecast



## Results (Beta Regression Model)

- In both epidemiological periods (pre-and post-peak of rCFR), the percentage of people aged 65 and above (IRR: 1.07, 95% CI: 1.04-1.10 and 1.01 [1.01-1.02], respectively),
- The prevalence of obesity (IRR: 0.97 [0.95-0.99] and 1.01 [1.01-1.02], and,
- COVID-19 tests per thousand population (0.98 [0.94-0.99] and 0.99 [0.98-0.99], respectively) were significantly associated with the COVID-19 rCFR (Table 1).

**Table 1. Factors associated with reported case-fatality rate (rCFR) of COVID-19 using beta regression analysis**

Variables	Before peak			After peak		
	IRR	95%CI	P-value	IRR	95%CI	P-value
Aged 65 and above	1.07	1.04-1.10	0.015	1.01	1.01-1.02	<0.001
Population density	1.01	1.01-1.02	0.006	1.01	1.00-1.01	0.514
COVID-19 total tests	0.98	0.98-0.99	0.026	0.99	0.98-0.99	0.002
GHSI	1.01	0.97-1.02	0.573	1.02	1.01-1.02	0.001
GDP	1.01	1.01-1.02	<0.001	1.01	1.00-1.01	0.349
WGI	0.67	0.51-0.89	0.006	1.07	1.04-1.10	<0.001
Obesity (%)	0.97	0.95-0.99	0.021	1.01	1.01-1.02	0.005

## Key findings

- Global cumulative rCFR of COVID-19 is decreasing since May 2020.
- However, the percentage of people aged 65 and above and related comorbidities (e.g. prevalence of obesity) of the country played a key role in the variation rCFR in different countries.
- Although number of tests/thousand population is negatively associated, our analyses indicate that the declining trend of global COVID-19 rCFR is not merely because of increased COVID-19 testing, as testing has poor predictive value.

## Limitations

- There are variation in capacities and readiness of countries in testing and reporting COVID-19 cases and deaths records, which might have affected overall data quality.
- We estimated the cumulative rCFR, which tends to underestimate the actual risk of death because the deaths that will occur in future are not included in the dataset.
- Both of these are universal limitation of CFR estimated used in most of the study using global COVID-19 data. To avoid, such strict conclusion, we used the term reported CFR.

## Conclusion

- Exact reasons for lowering rCFR need to study more in details but can be associated with improvement of health care management, use of drugs that shown improvement on the outcome and hospital stay.
- We recommend studying host level pathogenicity of the virus.

*Thank you!*