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Measuring Public Health Effect of Coronavirus Disease 2019: A Novel Perspective in Healthcare in Pandemic Times

Coronavirüs Hastalığının Halk Sağlığı Etkisinin Ölçülmesi 2019: Pandemi Zamanlarında Sağlık Hizmetlerinde Yeni Bir Perspektif

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ABSTRACT

Since the spark of the recent Severe Acute Respiratory Syndrome CoronaVirus 2 (SARS-CoV-2), public health concerns have motivated the accumulation of a vast amount of data about the Coronavirus Disease 2019 (COVID-19). The most important metrics for the pandemic progression are the recorded cases and reported deaths datasets which were comprehensively collected pertaining to the outbreak. The reliance on the census of morbidity and mortality lists solely appeared to be inadequate to assess or forecast the disease. It is proposed that a significant extension of this data should be amended to be much more useful for public health authorities and official organizations. It would be plausible to adopt a practical use of quantitative metrics that could be easily understandable and applied for measuring such a catastrophic pandemic. Three parameters that might be observed primarily involve assessing the outbreak magnitude, rate of change with time and the degree of stability of the difference in the rate of morbidities and mortalities at different intervals. In addition, empirical modeling implementation using the curve-fitting approach could be conducted to describe the pattern of the epidemic according to the cumulative daily datasets.

Keywords: SARS-CoV-2, cases, deaths, modeling, curve-fitting

ÖZ

Yakın zamanda ortaya çıkan Şiddetli Akut Solunum Sendromu CoronaVirus 2'nin (SARS-CoV-2) patlak vermesinden bu yana, halk sağlığı endişeleri, 2019 Koronavirüs Hastalığı (Covid-19) hakkında çok fazla veri toplanmasına neden olmuştur. Pandeminin ilerleyişine ilişkin en önemli ölçütler, salgına ilişkin kapsamlı bir şekilde toplanan kayıtlı vakalar ve bildirilen ölüm veri setleridir. Hastalığı değerlendirmek veya öngörmek için sadece morbidite ve mortalite sayılarına güvenmenin yetersiz olduğu ortaya çıkmıştır. Halk sağlığı otoriteleri ve resmi kuruluşlar için çok daha faydalı olması için bu verilerin önemli bir uzantısının değiştirilmesi önerilmektedir. Böylesine yıkıcı bir pandemiyi ölçmek için kolayca anlaşılabilecek ve uygulanabilecek niceliksel ölçütlerin pratik bir kullanımını benimsemek makul olacaktır. Gözlenebilecek başlıca üç parametre, salgının büyüklüğünü, zamanla değişim hızını ve farklı aralıklarla morbidite ve mortalite oranlarındaki farkın stabilite derecesini değerlendirmeyi içerir. Ek olarak, kümülatif günlük veri setlerine göre salgının modelini tanımlamak için en iyi eğri uydurma yaklaşımını kullanan ampirik modelleme uygulaması gerçekleştirilebilir.

Anahtar Sözcükler: SARS-CoV-2, vakalar, ölümler, modelleme, eğri uydurma

The recent viral outbreak of Coronavirus disease 2019 (COVID-19) demonstrated a practical affliction for the entire world and showed the unpreparedness of humanity to confront more devastating and lethal pandemics (1). It is proof of how the modern humanitarian is delicate despite the astonishing advancement in science and technology, in addition to almost every aspect of modern life. Despite the withering consequences of the recent war in Ukraine that sparked in 2022, especially on the world economy, the effect of Severe Acute Respiratory Syndrome CoronaVirus 2 (SARS-CoV-2) is still influencing the world (2). The media became somewhat distracted by the national and international consequences of this genuinely horrible war - with massive casualties - from the lasting creeping effect of this global pandemic.

In the internet era, Coronavirus COVID-19 (2019-nCoV) was subjected to extensive tracking, monitoring and recording of both cases and deaths by many public health organizations (3). Cumulative daily data could be easily deduced provided timely and accurate data collection, and the lag period before the emergence of the first reported deaths behind the initially ever recorded cases attributed to the Coronavirus infection could be easily calculated per each country (4). However, reporting of the recorded datasets alone provides little information for any crucial conclusions to be derived. Amendment of the archived morbidity and mortality censuses might be necessary to extract more meaningful outcomes from these databases. Transformation of the numbers, modeling and derivatization should be applied if more critical insight is needed (5).

We have suggested an initial visualization process be conducted using run charts, trending or process-behavior plots which might function as unique fingerprints for the progression of the epidemic waves in each geopolitical region or country. Three-dimensional graphical methods could be used as indispensable tools to monitor the progress of daily cases and deaths with time (6). Logarithmic transformation was adopted for the raw data to mitigate the dispersion and scattering of the recorded points and hence decrease the error factor in the presumed models. Moreover, there is a strong correlation between cumulative morbidities and mortalities, especially the transformed census of ill-dead populations (5). Morgan-Mercer-Flodin (MMF) model is best described as the non-linear appropriate curve fitting over the linear or polynomial regression for illness (x) versus death (y) mathematical description.

Based on the cumulative population survey, the magnitude and the number of outbreak waves could be deduced. Additionally, Modeling of the kinetics of the transformed cumulative pandemic indices showed convenient-fitting non-linear models in Table 1 for the major devastated countries (7, 8). Besides the MMF model (equation 1), the Exponential Association (EA) (equation 2) was observed to a lesser extent and the optimum correlation coefficient (r) and standard error (s) can be easily computed. The first-order derivatization to show the change of the epidemic parameter with time for both model types is shown by equations 3 and 4. The rate is projected into the dynamicity of the morbidities and mortalities (Figure 1). They can be calculated for short, medium and long-term outbreak levels. The degree of the stability of the daily rates of cases and deaths could be viewed also by estimating the acceleration or deceleration over different time intervals to demonstrate the change in the rates.

Table 1: Convenient-fit non-linear model for COVID-19 cases and deaths.

Geographical WHO Region	Transformed Cumulative Morbidity	Transformed Cumulative Mortality
USA	Exponential Association	Exponential Association
Brazil	Morgan-Mercer-Flodin	Morgan-Mercer-Flodin
India	Morgan-Mercer-Flodin	Morgan-Mercer-Flodin
Russia	Exponential Association	Morgan-Mercer-Flodin
UK	Morgan-Mercer-Flodin	Morgan-Mercer-Flodin

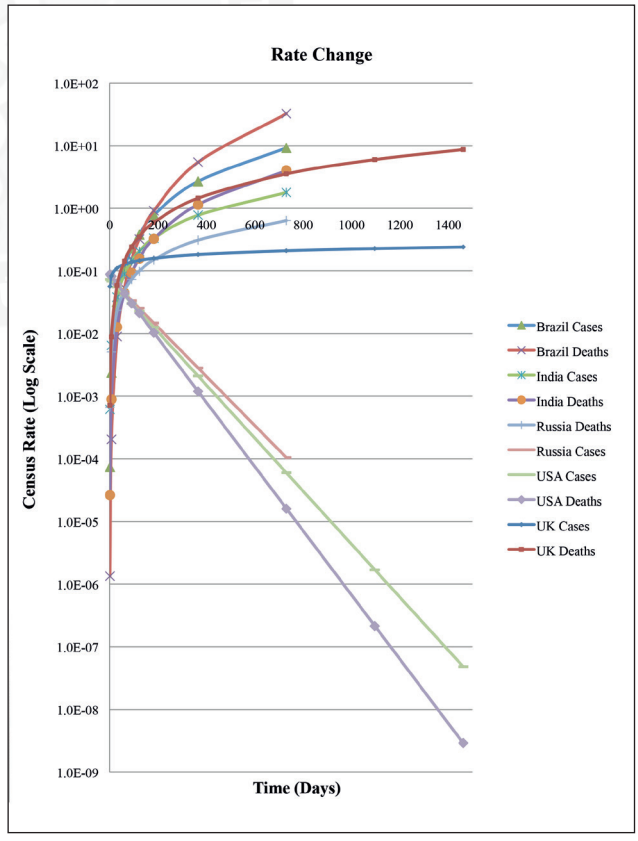

Figure 1: Change in morbidity and mortality rates with time from COVID-19 in the main impact political WHO regions.

$$y = \frac{(a.b + c.x^{d})}{(b + x^{d})} \quad (1)$$

$$y = a(b - e^{-cx}) \quad (2)$$

$$\frac{dy}{dx} = \frac{b.d.x^{d-1}(c - a)}{(b + x^{d})^{2}} \quad (3)$$

$$\frac{dy}{dx} = a.c.e^{-cx} \quad (4)$$

With the previous argument, we can say that the pandemic parameters of cases and deaths should be used by public health authorities and organizations to evaluate several important epidemic parameters (9). These metrics should reflect not only the magnitude of the outbreak census but also the rate of occurrence and the degree of change of this rate with time (10). Thus, they can be used effectively and quantitatively to assess the deterioration or improvement of disease mitigation strategy chronologically, the effectiveness or inefficiency of the containment measures and comparison between different political regions, states or districts. The comparison could be extended to different WHO regions, countries and nations to spot locations that need the greatest public health support and aid focus. The confocal message of this letter can be generalized to the epidemic as:

- Chronological pattern of the wave fingerprints within a particular time frame.
- Strong existence of a non-linear correlation between the cases and deaths from the disease.
- Non-linear suitable curve fitting model of Morgan-Mercer-Flodin followed by Exponential Association.
- The magnitude, rate and stability of the recorded metrics numbers are important parameters to be considered in the quantitative evaluation of the outbreak.

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Author Contributions

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Conflicts of Interest

No conflict of interest or common interest has been declared by the authors. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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This letter does not require ethics committee permission or any special permission.

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