2020-1054 IJOI
http://www.ijoi-online.org/

International Journal of Organizational Innovation

USING THE SEPARATION INDEX TO IDENTIFY THE MOST DOMINANT ROLE: A CASE OF APPLICATION ON COVID-19 OUTBREAK

Chi-Sheng Chang [1,2], Yu-Tsen Yeh [3], Tsair-Wei Chien[4], Jui-Chung John Lin[5], Bor-Wen Cheng[2], Feng-Jie Lai [6,7*]

[1]Center for Quality Management, Chi Mei Medical Center, Liouying,Tainan,Taiwan.

[2]Department of Industrial Engineering and Management, National Yunlin University of Science and Technology, Yunlin, Taiwan

[3] Medical School, St. George's University of London, London, United Kingdom

[4]Research Department, Chi-Mei Medical Center, Tainan, Taiwan

[5] USA Sports Medicine, Sherman oaks, CA,

[6]Department of Dermatology, Chi-Mei Medical Center, Tainan, Taiwan

[7]Center for General Education, Southern Taiwan University of Science and Technology, Tainan, Taiwan

[*]Corresponding Author: E-mail: smile@mail.chimei.org.tw

Abstract

The study aimed to introduce a new application of the separation index (SI) that allows objective determination of the dominant role in the COVID-19 outbreak which started in the city of Wuhan, China in December 2019 and subsequently spread to other provinces/regions of China as well as the rest of the world. The separation index is capable of determining the dominance, also defined as the absolute advantage (or disadvantage) in a comparable group of measures. We downloaded COVID-19

outbreak data on a daily basis from Google Sheet that provides information on confirmed cases in more than 30 Chinese locations and other countries/regions. Choropleth maps and Kano diagrams were drawn incorporating the 4SQ diagram. Three factors were assessed to determine which region played the most dominant role based on (1) the total number of confirmed cases, (2) the death rate, and (3) the SI of daily increase of confirmed cases using the separation index ranging from 0 to 1.0 (cutting at 0.70). We programmed Microsoft Excel VBA routines to arrange the data. Visual dashboards were created to display the results on Google Maps.

We observed that as of February 17, 2020, the top three countries/regions within the three respective elements investigated were Hubei (China), Philippines, and British Columbia, with SI of 0.98, 0.61, and 0.52, respectively.

The separation index is shown useful and capable in identifying the dominant role in a group. Further applications within and outside the context of COVID-19 are worthy of research effort.

Keywords: COVID-19, separation index, choropleth map, Kano model

Introduction

Under the influence of a pandemic like COVID-19, we hoped to develop an index that can determine the dominant roles in a vast group, one that is much similar to that used in determining the strength of the leading company in an industry in the study by Lee et al. (2020). The Herfindahl index (HI) was proposed as an indicator by economists Orris C. Herfindahl and Albert O. Hirschman (Hirschman, 1958) to investigate the competition in an industry (Catherine & Alan, 2004). However, there are disadvantages in the HHI defined as the sum of the squares of the market shares of the firms (i.e., $H=\sum_{i=1}^{n} s_i^2$, Where the number of firms in the industry, n, was limited to the 50 largest firms) (Lee et al., 2020). For instance, the market (s) shares are expressed as fractions (e.g., H= 0.5 = 0.5*0.5+ 0.5*0.5 for two equal- size companies). It would become a problem as the dominant role is what we are interested in (i.e., the 100% monopoly or the strength of the competition). The same applies to what we investigated in one questionnaire forming a unidimensional construct using Eigenvalues to definition (Chien 2012). The dimension coefficient (DC) is defined by the top three eigenvalues (λi) with

the formula: DC=[(λ1/λ2)/ (λ2/λ3)]/[1+[(λ1/λ2)/ (λ2/λ3)]] and a criterion of ≥0.70, where λi stands for the number of Eigenvalues in descending order (Lord, 1980; Divgi, 1980). The ratio[(λ1/λ2)/ (λ2/λ3)] can be defined as the separation index (SI) to represent the dominant role in a set of principal components. The application of SI in another field would be interesting but require evaluation.

This study aimed to apply the SI to determine the most dominant region regarding the current pandemic on the basis of (1) the number of confirmed cases, (2) the death rate, and (3) the SI of the increase of daily confirmed cases.

Methods

2.1. Data Sources

We downloaded COVID-19 outbreak data on February 14, 2020, from Google Sheet (Google, 2020) that provides information on confirmed cases in more than 30 Chinese locations and other countries/regions. All downloaded data were sourced from the websites (Google, 2020). Therefore, ethical approval was not necessary.

2.2 The separation index

We defined the SI, as mentioned in the previous study (Chien 2012; Lee et al., 2020). The formula is similar to the one for dimension coefficient (DC) (Lord, 1980; Divgi, 1980), and a threshold of 0.70 was chosen as the Cronbach Alpha to justify the quality of a scale. The higher the SI, the stronger the role one plays in a group, particularly in comparison to the next two.

2.3 The three elements are taken into consideration regarding the 2.4 corvid-19 outbreak

To evaluate the outbreak, three elements were taken into consideration: (1) the total number of confirmed cases, (2) the death rate, and (3) the SI of daily increase of confirmed cases where SI presents the strength of disparity with the next two countries/regions in descending order. As such, the SI is an algorithm used for understanding the feature of the dominant roles in a domain.

2.5 The choropleth map and the Kano diagram

Choropleth maps (CM) have been applied to illustrate the disparities in health outcomes across many disciplines (Chien et al., 2019). Some disadvantages were encountered when using them. For example,

the dominant nations are hard to discriminate or define on the Choropleth map. In light of the problem, the Kano diagram (Kano et al.,1984) and the separation index was deemed useful to complement CMs for a better interpretation of the disparities across countries and regions.

The Kano Model is based on a theory of product development and customer satisfaction developed in 1984 by Professor Noriaki Kano (Kano et al.,1984), who classifies products or items into three main categories of quality: basic requirement, one-dimensional quality, and exciting feature. These are diagrammed accordingly to the satisfaction perceived by customers on Y-axis and the effort achieved by providers on X-axis.

2.5 Creating Dashboards on Google Maps

Author-made modules showed research achievements on organization innovation for each country in Excel (Microsoft Corp). We created pages of HTML used for Google Maps. All the relevant information on the entities (i.e., countries or areas) can be linked to dashboards on Google Maps.

Results

The dominant regions on the COVID-19 outbreak were shown in Figure 1. Data were collected on February 17, 2020. We can see the top three regions on the number of confirmed cases were Hubei, Guangdong, and Henan (Mainland China). The problem with the choropleth map became obvious when the dominant region could not be shown. Whether the top rank, Hubei, has an SI over the threshold of 0.7 would need to be further addressed.

The Kano diagram was used to display the four- separation- quadrant (4SQ) diagram (Figure 2). The total numbers of confirmed cases were compared, and Hubei was found with SI=0.98 (>0.70), showing its dominant role played in the disease outbreak surpassing the next two of Guangdong, and Henan based on the formula (=0.98= [(59989/1322)/ (1322/1246)]/[1+ (59989/1322)/ (1322/1246)].

The top three regions by death rate on Feb. 17, 2020 were Philippines, France, and Taiwan with SI=0.61 (= [(0.33/0.08)/ (0.08/0.05)]/ [1+ (0.33/0.08)/ (0.08/0.05)].

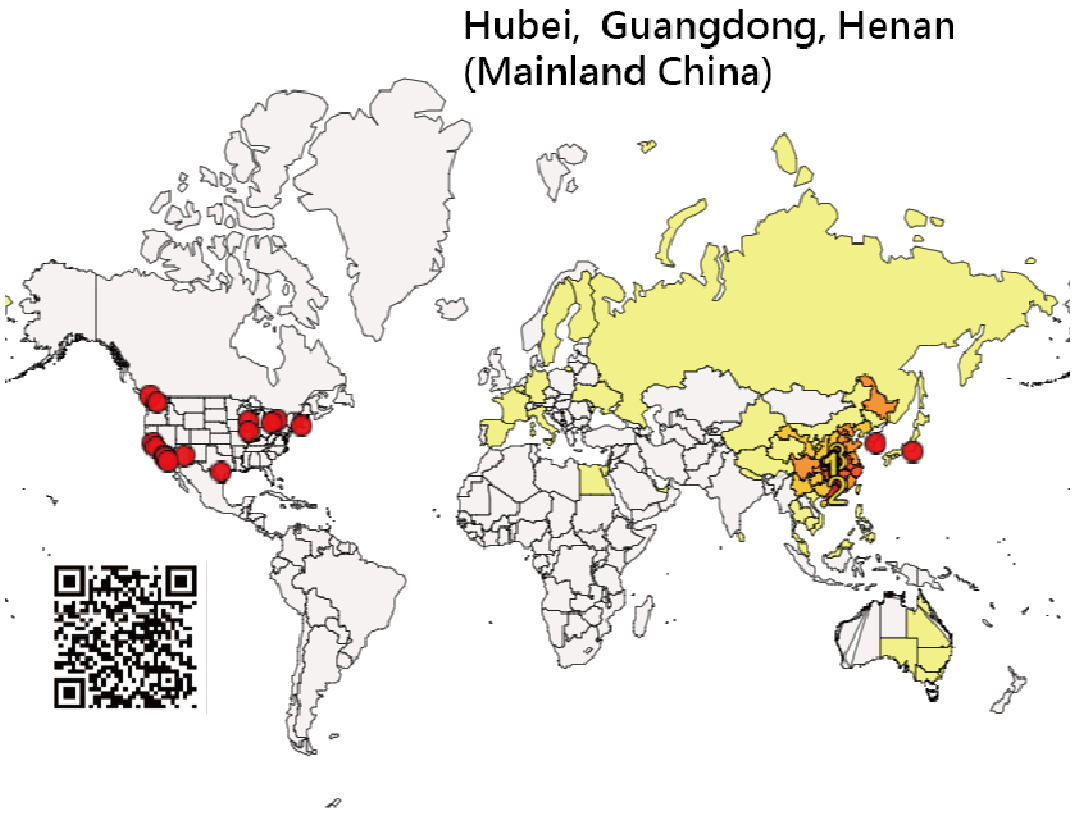


Figure 1. The dominant regions on COVID-19 outbreak on Feb. 17, 2020

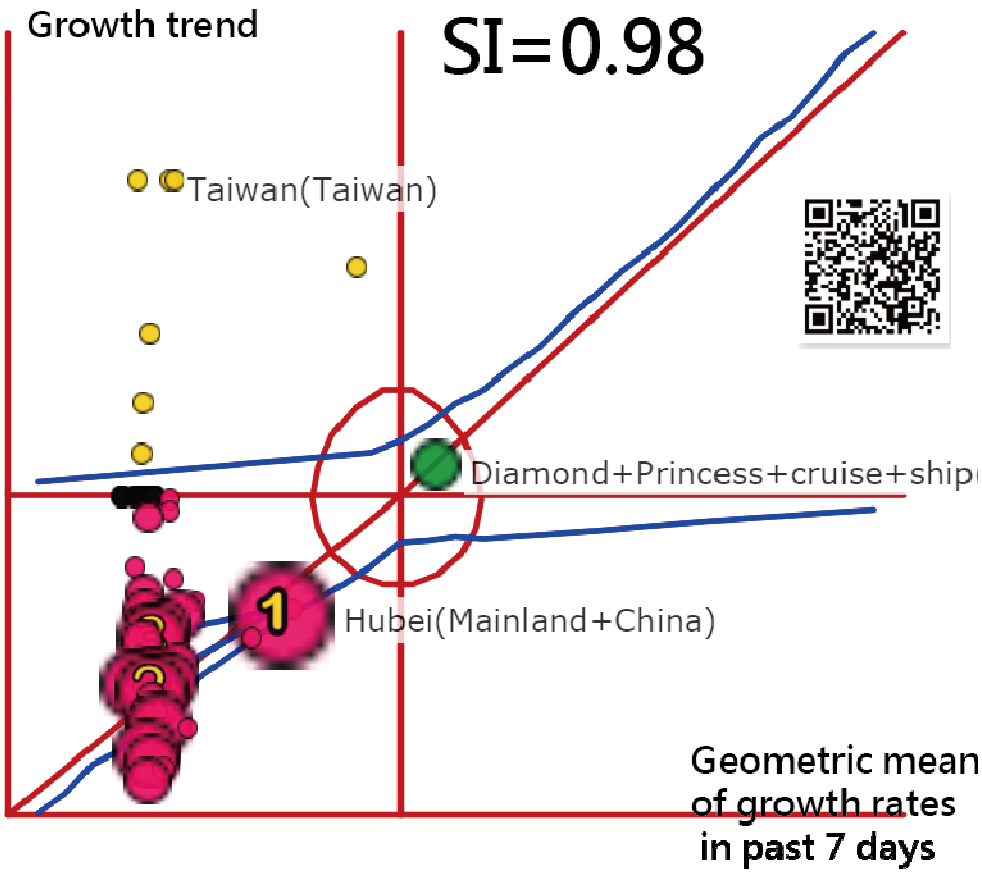
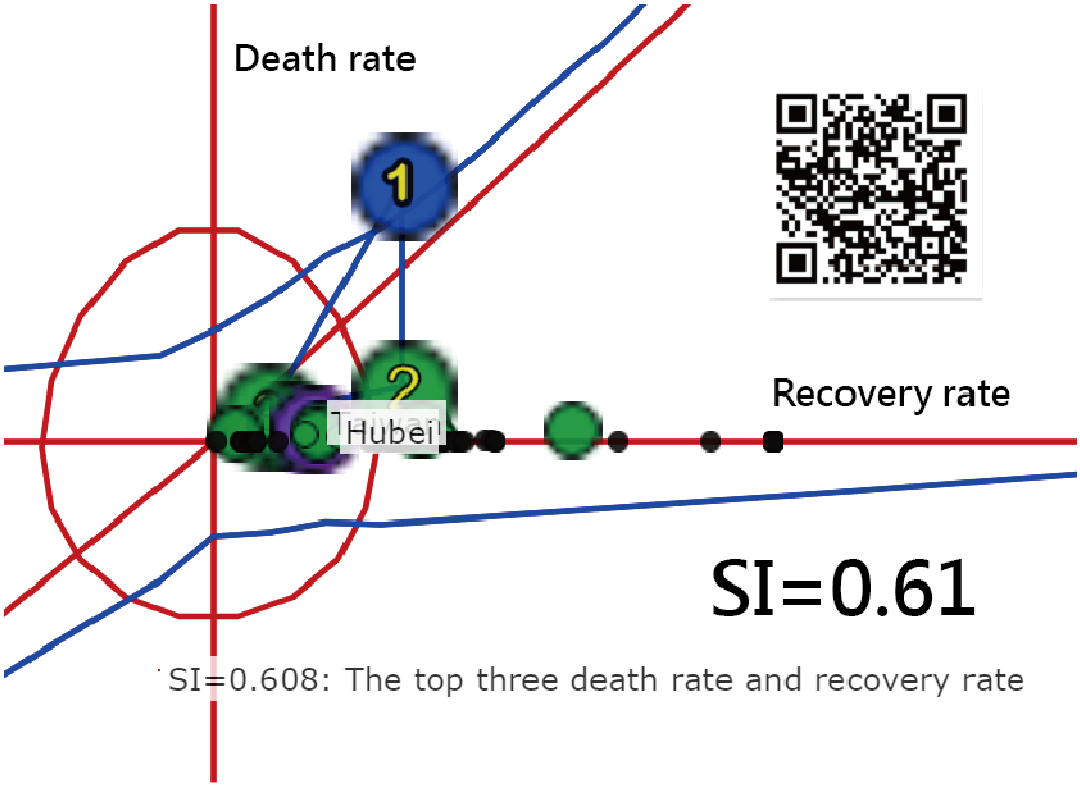


Figure 2. The dominant role with SI=0.98 derived from Hubei (China) using the Kano diagram to display



In Figure 3. The death rate dominated by the Philippines with SI=0.61

The top three with higher SIs of daily increase of confirmed cases were British Columbia (Canada), Diamond Princess cruise ship, and Hong Kong using the SI=0.52 (= [(0.56/0.51)/ (0.51/0.51)]/[1+ (0.56/0.51)/ (0.51/0.51)].

Discussions and Conclusion

We observed that as of February 17, 2020, the top three countries/regions within the three respective elements investigated were Hubei (China), Philippines, and British Columbia, with SI of 0.98, 0.61, and 0.52, respectively.

Although changes in the number of confirmed cases might be different in each SI on the topic of interest every day, the separation index is useful and capable in the determination of the dominant role of a group in comparison to the HHI where several limitations were found in use (Lee, 2020). We applied the SI to display the dominant regarding each data element on the COVID-19 outbreak, which has attracted attention from many around the world. The algorithm of SI allows the computers to easily display any outstanding roles from numerous entities quickly and accurately from

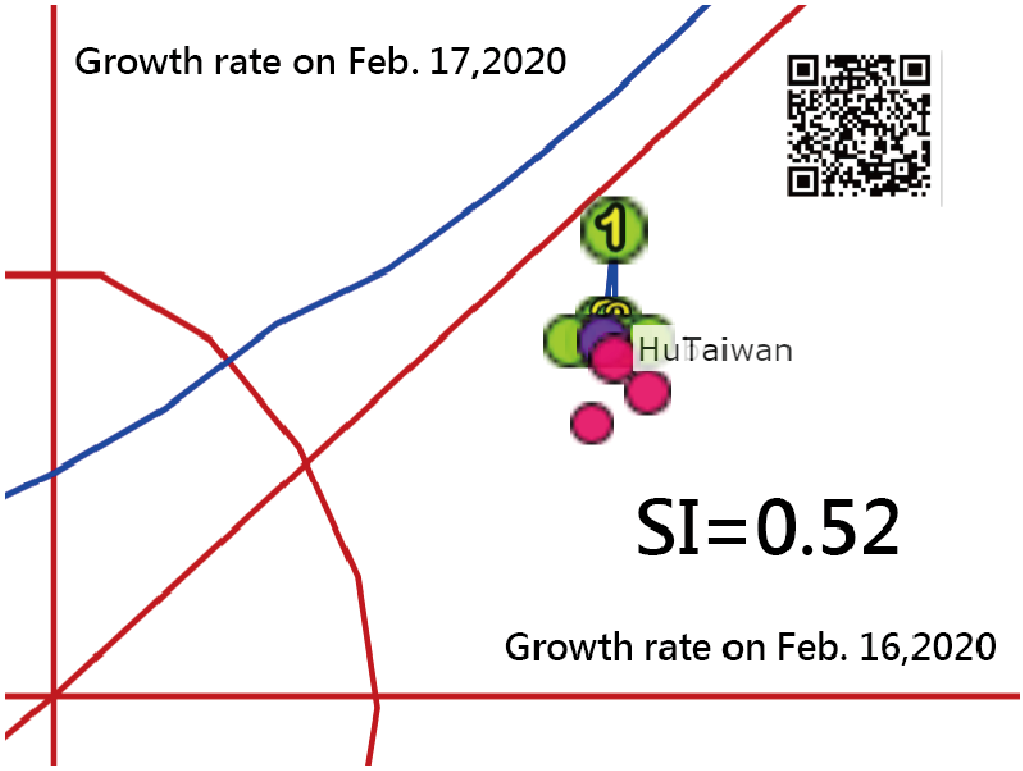


Figure 4. The dominant nation on organizational innovation is the US

the databank, for instance, when the region with most increased cases yesterday was of interest. The SI with visualization, as provided in this study, can be easily modified to any other topic of interest and presented on Google Maps. Interested readers are invited to scan the QR-code on Figures and click on the bubble on the Kano diagrams (or the color on choropleth map) to see the detailed information of each specific region.

We demonstrated the use of SI on the evaluation of COVID-19 that can be applied to other fields of study in the future. All dashboards created using Google Maps is also a feature that can be easily replicated future research.

As of February 18, 2020, more than 163 articles related to COVID-19 have been searched on PubMed Central (PMC) (PubMed Central,2020). The Johns Hopkins Center for Systems Science and Engineering (JHC) has built an online dashboard regularly updating the data for tracking the spread of the

COVID-19 worldwide (Donovan, 2020) in the hope of providing the public a better understanding of the outbreak. However, nothing as innovative as applying SI in evaluating and providing such aspect of the disease outbreak has been introduced to the public so far.

Similarly, the SI can be complementary to the dashboards despite the bubble size representing the magnitudes on the Kano diagram. The bubble locations on the Kano diagram are more distinguishable than any other types of visual representations in the past. Regardless, the most worth- noting feature in this study remains to be the novel application of SI.

In situations of day-to-day livings, we can also encounter the need to identify the dominant role in an organization or a group. For instance, the top three players in the 2019 World Athletics Championships of Men's decathlon scored 9126, 9045, and 8711. The person's reliability is equal to 0.48 (<0.70), implying that the top player does not play a dominant role, and the second player in ranking closely follows the first.

The second feature of this study is applying the choropleth map and the Kano model, as we did in the previous study (Lin, Chou, Chou, Chien, 2019). Several potential limitations may encourage further research efforts. First, as all data were extracted from the Google Sheet on COVID-19, numerous elements could be and should be involved in the use of SI to highlight the dominant roles, but only three were raised in this study. Second, the proposed separation index itself has several limitations. The last two regions/entities would be not involved in the computation because of the need to compare one with the next two in descending order (Lee, 2020). An simple way to examine the last two is using the F2/F1 indicating the inversed result (e.g., (F1/F2)/ (1+ (F1/F2))=1- (F2/F1)/ (1+ (F2/F1)) in nature. The condition is that we use the SI to separate the groups or clusters, instead of limiting to the top three.

Third, the study was based on the data from the Google Sheet (Google, 2020). The Google team has announced that the service will be terminated and transformed into Github[28], providing the same information. Due to the download limit, the Google team will soon stop the update of this Google Sheet, which might affect the data being transferred effectively and efficiently on the daily calculated SIs on our

dashboards.

In conclusion, the separation index is useful and capable of identifying the dominant role in a group. Further applications within and outside the context of COVID-19 are worthy of research effort.

References

Catherine, L.-H., Alan, P. (2004). Inventive Concentration: An Analysis of Fuel Cell Patents. *Science and Public Policy, 31:*1, 15-25.

Chien, T.W. (2012). Cronbach's Alpha with the Dimension Coefficient to Jointly Assess a Scale's Quality. *Rasch Measurement Transactions, 26:*3, 1379

Chien, T.W., Wang, H.Y., Hsu, C.F., Kuo, S.C. (2019). Choropleth map legend design for visualizing the most influential areas in article citation disparities: A bibliometric study.*Medicine (Baltimore), 98*: 41, e1752

Chien, T.W., Wang, H.Y., Lai. (2019). Applying an Author-Weighted Scheme to Identify the Most Influential Countries in Research Achievements on Skin Cancer: Observational Study.*JMIR Dermatol., 2* (1),e11015

Divgi, D.R. (1980). Dimensionality of binary items: Use of a mixed model. Paper presented at the annual meeting of the National Council on Measurement in Education. Boston, MA.

Donovan, D. (2020) Map tracks coronavirus outbreak in near real time.2020/2/9 available at https://hub.jhu.edu/2020/01/23/coronavirus- outbreak- mapping-tool-649-em1-art1-dtd-health/

Google Sheet (2020). Novel Coronavirus (2019-nCoV) Cases, provided by JHU CSSE. 2020/2/9 available at https://docs.google.com/spreadsheets/d/1wQVypefm946ch4XDp37uZ-wartW4V7ILdg-qYiDXUHM/htmlview?usp=sharing&sle=true

Google Team (2020). 2019 Novel Coronavirus (nCoV) Data Repository. 2020/2/9 available at https://github.com/CSSEGISandData/2019-nCoV

Hirschman, A. O. (1958) The Strategy of Economic Development. Yale University Press.

Huang, T.L., Wu, J.H., Chien, T.W. (2019). Exploring the relation-

ship between medical organization innovaiton and other medicl subjects using social network analysis. *The International Journal of Organizational Innovation,12*:1, 45-54.

Kano, N., Seraku, N., Takahashi, F., Tsuji, S. (1984). Attractive Quality and Must-Be Quality. *Journal of the Japanese Society for Quality Control , 41*, 39-48.

Lee, C.J., Chou, W., Chien, T.W., Yeh, Y.T., Jen, T.H. (2020). Using the Separation Index for Identifying the Dominant Role in an Organization: A case of Publications in Organizational Innovation, *Journal of Organizational Innovation 2020;* in press.

Lin, C.H., Chou, P.H., Chou, W., Chien, T.W. (2019).Using the Kano model to display the most cited authors and affiliated countries in schizophrenia research. Schizophr Res., pii: S0920-9964 (19)30493-1.

Lord, F.M. (1980). Applications of item response theory to practical testing problems. Hillside, NJ: Erlbaum.

Pubmed Central (2020). Articles related to 2019-nCoV in Pubmed. 2020/2/9 available at https://www.ncbi.nlm.nih.gov/pubmed/?term=2019-nCoV