Acta Scientific Veterinary Sciences (ISSN: 2582-3183)

Volume 3 Issue 7 July 2021

Research Article

Forecast of New and Deceased Cases of COVID-19 in Cuba with an Advance of 105 Days

Ricardo Osés Rodríguez[1], Rigoberto Fimia Duarte[2,3]*, Claudia Osés Llanes[4], María Patricia Zambrano Gavilanes[5], Thainâh Bruna Santos Zambrano[6] and Alfredo González Meneses[7]

[1]Provincial Meteorological Center of Villa Clara, Cuba

[2]Faculty of Health Technology and Nursing, University of Medical Sciences of Villa Clara (UMC-VC), Cuba

[3]Veterinary Medicine and Zootechnic Career, Faculty of Agrocultural Sciences, Central University "Marta Abreu" of Las Villas, Villa Clara, Cuba

[4]Department of Hygiene and Epidemiology, XX Anniversary Policlinical, Santa Clara, Villa Clara, Cuba

[5]Veterinary Medicine Career, Faculty of Veterinary Medicine and Zootechnic, Technical University of Manabí, Manabí, Ecuador

[6]Pathology Department, St. Gregory's University of Portoviejo, Portoviejo, Ecuador and Postgraduate Department in Biomedicine, Italian University Institute of Rosario (IUNIR), Argentine

[7]Construction Enterprise of the Electric Industry of Villa Clara, Cuba

***Corresponding Author:** Rigoberto Fimia Duarte, Hygiene and Epidemiology Career, Faculty of Health Technology and Nursing, University of Medical Sciences of Villa Clara (UMC-VC), Cuba.

Received: May 10, 2021

Published: June 23, 2021

Abstract

In this work, new cases and daily deaths of the COVID-19 pandemic affecting Cuba so far in the year 2021 were modeled. Mathematical models were obtained by means of the methodology of Regressive Objective Regression (ROR), which explains their behavior, depending on 105 days in advance, a parameter which is related to a delay of 4 months. A long-term prognosis was performed, which allows taking measures in clinical services to reduce deaths and complications in patients with COVID-19. It is concluded that COVID-19, despite being a new disease in the world, can be predicted 105 days in advance by means of ROR mathematical modeling, which allows reducing the number of deceased, severe, and critical patients for better management of the pandemic. The tendency of the disease is on the rise, so the management, monitoring, and control of the disease should continue to be taken to the extreme, as established in the medical protocols. An accumulated number of 1000 deaths could be reached by August 19, 2021, and 500 deaths by April 15, 2021, according to the models run.

Keywords: Cuba; COVID-19; New Cases; Deaths; Long Term Prognosis; Regressive Objective Regression

Introduction

The importance of climate on human well-being was recognized since ancient times [1,2]. The relationship between man and climate was defined by Hippocrates (460 years BC) [3]. The Father of Medicine stated: "Whoever wishes to follow precisely the science of medicine, must take into account what effects each season of the year may produce, for the seasons are not similar, but vary. Therefore, seasonal diseases of man, such as his digestive complaints, undergo changes".

Acute respiratory infections (ARI) represent the leading cause of morbidity in the world [2,4,5], where the most frequent cause of health services utilization in all countries; between 30 and 50% of children's visits to health facilities and between 20 and 40% of pediatric hospitalizations in most developing countries [5,6]. It is estimated that a child in an urban area suffers from five to nine episodes of ARI per year during the first five years of life. It is also the most common cause of mortality in children under five years of age in the developing world [5-8]. Acute respiratory infection is one of the most frequent causes of morbidity in the province of Villa Clara, with a higher incidence in the municipalities of Remedios, Ranchuelo, and Placetas [9,10].

The current situation that the planet is experiencing due to the new coronavirus, is one more trigger, the product of multiple factors, with a high share derived from anthropogenic activity [11,12]. Two major epidemics have been described, severe acute respiratory syndrome due to coronavirus (SARS-CoV) in 2002 and the Middle East respiratory syndrome (MERSCoV) in 2012, until SARS-CoV-2 or COVID-19 (from Coronavirus Infection Disease) appeared in China in December 2019, hereafter referred to in this article as coronavirus [13-15].

Global epidemiological studies of coronavirus (CoV) over 15 years have shown that bats in Asia, Europe, Africa, America, and Australia harbor a wide variety of viruses, which harbor and spread these infectious agents quite easily, increasing their ability to transmit [16-18].

Several models and methodologies have been applied in the study, analysis, and modeling of COVID-19 in the world, among which the following stand out: Ordinary Differential Equation of First Order (EDOPO), linear type; Simple linear Regression model; Generalized Logistic Growth Model (GLM); Structured Susceptible-Exposed-Infected-Removed (SEIR)/SEIR model; the Bayesian Probability Mathematical Model; SIRD model; Conceptual Model and the Simulation Model, among many others [19-25]. By virtue of this, it is important to estimate the trend in the behavior of the epidemiological curve of the COVID-19 pandemic [23-26].

Aim of the Study

The aim of this study was to mathematically model the behavior of new and deceased cases of COVID-19, as well as to predict, 105 days in advance, the confirmed cases in Cuba.

Materials and Methods

Data collection

For this work, we used pandemic data on new and deceased cases in Cuba taken from Cuban television and radio since the pandemic began in March 2020. By the end of March 2020, 424 people had died in Cuba due to COVID-19 and a total of 1051 cases were reported on March 31.

ROR model

The prognosis was performed using the methodology of Regressive Objective Regression (ROR), which has been implemented in different variables such as viruses circulating in Villa Clara province [10]. A very long-term forecast was performed until August 31, 2021, with data were taken until March 6, 2021.

In this methodology, the dichotomous variables DS, DI, and NoC must first be created, where: NoC: Number of cases of the base (its coefficient in the model represents the trend of the series). DS = 1, if NoC is odd; DI = 0, if NoC is even, and vice versa. DS represents a sawtooth function and DI this same function, but in inverted form, so that the variable to be modeled is trapped between these parameters and a large amount of variance is explained [27]. All the data processing was carried out with the help of the SPSS statistical package, Version 19, from the IBM company.

The ROR methodology consists of several steps [10,28] and allows not only to mathematically model the larval densities of mosquitoes, as well as the population dynamics of mollusks but goes further (possibility of modeling infectious entities of different etiologies, such as the HIV/AIDS, Cholera, Influences, Acute Respiratory Infections (ARI), Acute Bronchial Asthma Crises (CAAB), Fasciolosis, Angiostrongylosis and even, in the estimation of the length and area of the universe, monthly forecast of rainfall and extreme temperatures, the prognosis of meteorological disturbances/hurricanes, prediction of the latitude and longitude of earthquakes, the search of information in white noise, modeling of the equivalent effective temperature (TEE) and atmospheric pressure (PA) to the own electricity consumption of a municipality, province or nation [29-34].

Results

The following are the results obtained for the first days of August according to the ROR methodology. It can be seen how the autocorrelation functions (ACF) reach the point of change to zero during the 105-day delay (Figure 1). Future work should include some meteorological variables, specifically temperature and humidity.

Figure 1: Significant lags for new data confirmed by COVID-19 in Cuba.

(Note lag 105 as very significant as the pattern is repeatable)

In table 1, a summary of the model obtained, explains 94% of the variance, with an error of 123 cases, as it is a model used for the long term the Durbin Watson statistic is small, which allows introduction in the future model more independent variables if necessary.

Model	R	R square[d]	Adjusted R-square	Standard error of estimation	Durbin-Watson
1	.940[a]	.884	.872	122.9537	.419

Table 1: Summary of model[c, d].

a. Predictors: Step325, Step324, Step320, Step314, Step313, Step303, Step302, Step301, Step323, Step322, Step161, Step162, Step152, DS, DI, Lag105News, NoC.

b. For regression through the origin (the model without intercept), R-squared measures the proportion of the variability in the dependent variable about the origin explained by the regression. This CANNOT be compared to R-squared for models that include intercept.

c. Dependent variable: News.

d. Linear regression through the origin.

The model obtained in table 2 has a positive trend significant at 100% as well as the lag parameter 105 (Lag105 New), with this result we can go in the forecast 105 days into the future of the pandemic. The Step variables are cases that contribute variance to the model, and although some are not significant we prefer to leave them in the model because in previous short-term models they were significant.

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
B		Standard error	Beta			
1	DS	-535.698	30.655	-1.102	-17.475	.000
	DI	-536.639	30.478	-1.104	-17.608	.000
	Tendency	2.987	.141	1.939	21.261	.000
	Lag105 News	3.836	.455	.369	8.432	.000
	Step152	98.817	123.893	.021	.798	.426
	Step162	35.924	123.860	.008	.290	.772
	Step161	59.662	123.835	.013	.482	.631
	Step322	291.624	124.914	.063	2.335	.021
	Step323	292.166	124.741	.063	2.342	.020
	Step301	-323.676	124.487	-.070	-2.600	.010
	Step302	-318.030	124.417	-.069	-2.556	.011
	Step303	-208.959	124.385	-.045	-1.680	.095
	Step313	112.513	124.506	.024	.904	.368
	Step314	-255.206	124.565	-.055	-2.049	.042
	Step320	130.253	124.779	.028	1.044	.298
	Step324	19.863	125.082	.004	.159	.874
	Step325	24.280	124.894	.005	.194	.846

Table 2: Coefficients[a, b].

a. Dependent variable: News.

b. Linear regression through the origin.

The 105 days ahead forecast is shown in figure 2, a significant increase in cases can be seen. If the trends of this model were to continue and the pandemic is not managed with severe measures, this would be an unfavorable scenario for decision-makers.

Figure 2: Forecast of new cases for Cuba according to ROR methodology.

Deaths were also estimated according to the calculations of expected new cases, with deaths increasing by more than 6 per day (Figure 3).

Figure 3: Expected deaths taking into account long-term prognoses of new cases.

A cumulative number of 1000 deaths could be reached by August 19, 2021, and 500 deaths by April 15 according to the running models (Figure 4).

Figure 4: Accumulated predicted deaths based on new cases estimated by the ROR model 105 days in advance.

Discussion

By including the delay in the series, an advance in the prognosis is obtained, a result that coincides with that obtained by other authors in a study for acute respiratory infections four months in advance and its relationship with the "El Niño" event (ENSO) for the province of Villa Clara [35], although the 105 days correspond here to three months and 15 days, so we believe that this delay can be considered correlated with the four months since COVID-19 is classified as an ARI and in published works, we have worked with monthly data [27,36,37].

The meteorological variables: ambient temperature and relative humidity turned out to be those most related to the decrease and increase of ARI cases, which agrees with results obtained by other authors in this regard [38-42] and even, for other infectious entities, groups of organisms and disasters of natural origin [43-45]. In order to predict severe cases of ARI, the value of the minimum temperature, which explains 90.3%, should be taken into account as a predictor, since as the minimum temperature increases by 1°C, this causes severe cases to increase by 2.3 cases, which is very important in the management of the pandemic [13,35,36].

It is interesting to note that the ROR methodology explains 9 to 10% more variance than any other existing model [22,28,38,46], by extracting information on white noise, unfortunately, due to the pandemic itself, which imposes mobility and resource constraints, it is impossible to run other models, but it would be very interesting in the future to compare these results with other prediction models.

Conclusion

It is concluded that COVID-19, despite being a new disease in the world, can be predicted 105 days in advance by means of mathematical modeling ROR, which allows to reduce the number of dead, severe, and critical patients for better management of the pandemic. The tendency of the disease is on the rise, so the management of the disease should continue according to medical protocols in line with the evolution of the pandemic worldwide, allowing medical personnel who deal directly with these patients to make timely decisions in order to save a greater number of lives. This conclusion allows researchers in other countries to use the 105 days discovered in our research to be able to anticipate the expected and to have an arsenal of measures to control the causes of deaths and to be able to measure the effectiveness of the medical services of each country.

Acknowledgements

We would like to thank Dr. Luis B. Lecha Estela for providing part of the database with which we have worked and Mr. Ángel Félix Osés Gómez for completing the data from Cuban television, without which it would not have been possible to run the models.

Bibliography

1. Haines A and Patz JA. "Health effects of climate Change". *American Medical Association* 291 (2004): 32-38.
2. Anonymous J. American Journal of Respiratory and Critical Care Medicine (2009).
3. Macklis R., *et al*. "Manual of introductory clinical medicine". *Library of Congress Catalogo, USA* 83 (1987): 80296.
4. Blackall J. "Infectious Coryza: Overview of the disease and new diagnostic options". *Clinical Microbiology Reviews* 12 (1999): 627-632.
5. Nicholson KG., *et al*. "Influenza". *Lancet* 362 (2003): 1733-1745.
6. Sánchez TN. "Infecciones respiratorias agudas". *Reporte Técnico de Vigilancia* 1 (1996).
7. Gilbert M., *et al*. "Climate change and avian influenza". *Revue Scientifique Et Technique* 27 (2008): 459-466.
8. Jaakkola K., *et al*. "Decline in temperature and humidity increases the occurrence of influenza in cold climate". *Environmental Health* 13 (2014): 17-22.
9. Artiles SJM. **"**Caracterización epidemiológica y climatológica de las atenciones por Infecciones Respiratorias Agudas. Villa Clara 2015-2016" [Tesis para optar por el título de Especialista de Primer Grado en Higiene y Epidemiología]. Centro Provincial de Higiene, Epidemiología y Microbiología (CPHEM), Villa Clara, Cuba (2017).
10. Sánchez ÁML., *et al*. "La Regresión Objetiva Regresiva más allá de un ruido blanco para los virus que circulan en la provincia Villa Clara, Cuba". *The Biologist (Lima)* 15 (2017): 127.
11. Fimia DR., *et al*. "Factores antropogénicos y ambientales sobre la fauna de culícidos (Diptera: Culicidae) de la provincia Sancti Spíritus, Cuba". *The Biologist (Lima)* 13 (2015): 41-51.
12. Fimia DR., *et al*. "Asociación de algunas variables climáticas con la fasciolosis, angiostrongilosis y la malacofauna fluvial de la provincia Villa Clara, Cuba". *Neotropical Helminthology (aphia)* 10 (2016): 259-273.
13. Prem K., *et al*. "The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modeling study" (2020).
14. Salas AR., *et al*. "Coronavirus COVID-19: Conociendo al causante de la pandemia". *The Biologist (Lima)* 18 (2020): 9-27.
15. Sun Z., *et al*. "Potential Factors Influencing Repeated SARS Outbreaks in China". *International Journal of Environmental Research and Public Health* 17 (2020): 1633.
16. Fan Y., *et al*. "Bat Coronaviruses in China". *Viruses* 11 (2019): 1-14.
17. Wang LS., *et al.* "A review of the 2019 Novel Coronavirus (COVID-19) based on current evidence". *International Journal of Antimicrobial Agents* (2020).
18. Woo PCY and Lau SKP. "Viruses and Bats". *Viruses* 11 (2019): 880-884.
19. Rue H., *et al*. "Bayesian computing with INLA: a Review". *Annual Reviews of Statistics and its Applications* 4 (2017): 395-421.
20. Simpson DP., *et al*. "Penalising model component complexity: a principled, practical approach to constructing priors". *Statistics Sciences* 32 (2017): 1-46.
21. Anastassopoulou C., *et al*. "Data-based analysis, modeling and forecasting of the COVID-19 outbreak". *PLOS ONE* 15 (2020): 1-21.
22. Roosa K., *et al*. "Real-time forecasts of the COVID-19 epidemic in China from February 5th to February 24th, 2020". *Infectious Disease Modelling* 5 (2020): 256-263.
23. Zhao S and Chen H. "Modeling the epidemic dynamics and control of COVID-19 outbreak in China". *Quantitative Biology* 8 (2020): 11-19.
24. Zhao S., *et al*. "Preliminary estimation of the basic reproduction number of novel coronavirus (2019-n CoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the outbreak". *International Journal of Infectious Diseases* 92 (2020a): 214-217.
25. Zhao S., *et al*. "Estimating the Unreported Number of Novel Coronavirus (2019-n CoV) Cases in China in the First Half of January 2020: A Data-Driven Modelling Analysis of the Early Outbreak". *Journal of Clinical Medicine* 9 (2020b): 388.
26. Saez M., *et al*. "Effectiveness of the measures to flatten the epidemic curve of COVID-19. The case of Spain". *Science of the Total Environment* 727 (2020): 138761.
27. Fimia DR. "Mathematical modeling of population dynamics of the *Aedes aegypti* (Diptera: Culicidae) mosquito with some climatic variables in Villa Clara, Cuba". *International Journal of Zoology and Animal Biology (IZAB)* 3 (2020): 16000233.

28. Osés RR., *et al*. "The ROR's methodology an it's possibility to find information in a White noise". *International Journal of Current Research* 9 (2017): 47378-47382.

29. Osés RR., *et al*. "Prediction of latitude and longitude of earthquakes at global level using the Regressive Objective Regression method". *Advances in Theoretical and Computational Physics* 1 (2018): 1-5.

30. Osés RR., *et al*. "Modelación ROR aplicada a pronósticos". Editorial Académica Española (eae). Editorial de OmniScriptum Publishing KS. Brivibas gatve 197, Riga, LV-1039 Latvia, European Union. (2019a).

31. Osés RR., *et al*. "Estudio del consumo eléctrico provincial de Villa Clara y su pronóstico 2019-2023 Cuba". *Revista ECOSOLAR* 65 (2019b): 32-43.

32. Hernández CN., *et al*. "Determinación de la ictiofauna que participa en el control de culícidos en sistemas acuáticos del municipio Guamá, Santiago de Cuba". *Revista Cubana Medicina Tropical* 58 (2006): 32-36.

33. Osés RR., *et al*. "Modelación matemática del cólera por medio de la Regresión Objetiva Regresiva y su relación con las variables climáticas. Caibarién, Villa Clara, Cuba". *The Biologist (Lima)* 15 (2017): 128-134.

34. Fimia DR., *et al*. "La entomofauna de culícidos y los copépodos abordados desde las alternativas de control biológico hasta la modelación matemática en dos provincias centrales de Cuba". *Anales de la Academia de Ciencias de Cuba* 10 (2020a): 1-11.

35. Osés RR., *et al*. "Pronostico a muy largo plazo de casos graves de COVID-19 para Cuba". En: Libro de Ponencias: VI Taller Cambio Climático y Salud. Sagua la Grande, Villa Clara, Cuba (2020): 7-15.

36. Osés RR., *et al*. "Pronóstico de la COVID-19 por medio de la metodología de Regresión Objetiva Regresiva en Villa Clara, Cuba". *The Biologist (Lima)* 18 (2020): 171-184.

37. Osés RR., *et al*. "Age prediction for COVID-19 suspects and contacts in Villa Clara province, Cuba". *EC Veterinary Science* 6 (2021): 41-51.

38. Osés RR., *et al*. "How to predict the Climatic Bultó Index with a year in advance?". *International Journal of Agriculture Innovations and Research* 4 (2015a): 11-17.

39. Osés RR., *et al*. "Climatic impact of the temperature in the presence of cold avian infections in Cuba". *International Journal of Development Research* 5 (2015b): 14-19.

40. Osés RR., *et al*. "Regressive methodology (ROR) VERSUS Genetic Code in mutations of VIH". *International Journal of Agriculture Innovations and Research* 3 (2015a): 2319-1473.

41. Osés RR., *et al*. "Climatic impact of the temperature in the presence of cold avian infections in Cuba". *International Journal of Development Research* 5 (2015b).

42. Osés RR., *et al*. "Modelación de la temperatura efectiva equivalente para la estación del Yabú y para la densidad larval total de mosquitos en Caibarién, provincia Villa Clara, Cuba". *Rev Peruana de Entomología* 51 (2016): 1-7.

43. Fimia DR., *et al*. "Modeling of Equivalent Effective Temperature and its possible incidence on larval density of *Anopheles* mosquitoes (Diptera: Culicidae) in Villa Clara province, Cuba". *Revista de Biología Tropical (RBT)* 65 (2017): 565-573.

44. Fimia DR., *et al*. "Modelación matemática del efecto de la presión atmosférica sobre la densidad poblacional de los mosquitos (Diptera: Culicidae) en Villa Clara, Cuba". *Revista de la Facultad de Medicina* 68 (2020b): 541-549.

45. Fimia DR. "Points of Interest for the New Coronavirus SARS-CoV-2 Causing COVID-19". *EC Veterinary Science* 5 (2020c): 1-2.

46. Osés RR., *et al*. "Modelación de la densidad larvaria total de mosquitos (*Diptera: Culicidae*) utilizando tres modelos en la provincia de Villa Clara, Cuba". *REDVET* 15 (2014).

Volume 3 Issue 7 July 2021