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ARTICLE

Methodology of The Objective Regressive Regression In Function of The Prognosis For Deaths, Critical, Severe, Confirmed And New Cases of Covid-19 In Santa Clara Municipality And Cuba

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Abstract
The COVID-19 pandemic affecting planet Earth has had a peculiar development in our country. Objective: The objective of the research was to model, using the Regressive Objective Regression (ROR) methodology, a set of parameters (deaths, critical, severe, confirmed and new cases) inherent to the SARS CoV-2 COVID-19 pandemic, so far in 2020 in Cuba. The parameters analyzed were: deaths, serious, critical, confirmed and new cases, in the municipality of Santa Clara, Villa Clara and Cuba. The modeling used was Regressive Objective Regression (ROR) modeling, which is based on a combination of Dummy variables with ARIMA modeling. In the ROR methodology, dichotomous variables DS, DI and NoC are created in a first step, and then the module corresponding to the Regression analysis of the statistical package SPSS version 19.0 is executed, specifically the ENTER method where the predicted variable and the ERROR are obtained. Mathematical models were obtained by means of the ROR methodology that explain the behavior of the same, depending on the variable to study, 6, 4, 10 and 14 days in advance, which made it possible to make long term prognoses, allowing to take measures in the clinical services, and thus to avoid and to diminish the number of deaths and complications in patients with COVID-19. Despite being a new disease in the world, COVID-19 can be followed by means of ROR mathematical modeling. This allows for a decrease in the number of dead, serious and critical patients for a better management of the pandemic.

Key words: COVID-19, critics, Cuba, deceased, severe, mathematical models, pandemic, Regressive Objective Regression, Santa Clara.

1 | INTRODUCTION

Since the dawn of civilization, infectious diseases have affected humans (1), (2). The early history of these diseases was characterized by sudden and unpredictable outbreaks, often of epidemic proportions (3), (4) , so the current situation that the planet is experiencing due to the new coron-avirus is one more trigger product of multiple fac-tors, with a high share derived from anthropogenic activity (5), (6) .Two major epidemics have been described, severe acute respiratory

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syndrome (MERSCoV) in 2012, until SARS-CoV-2 or COVID-19 (Coronavirus Infection Disease) appeared in China in December 2019, hereafter referred to in this article as coronavirus (7).

Coronaviruses belong to the family Coronaviridae. The size of the genomes varies between 26 to 32 kilonucleotides, being one of the largest RNA-positive viruses (8). They have a helically symmetric nucleocapsid with an envelope that has glycoprotein structures resembling a crown of spikes (hence they have been called coronaviruses) (9), (10).

Coronaviruses can cause respiratory and digestive diseases, both in birds and mammals, including humans, in which they can produce diseases ranging from a common cold to more severe symptoms such as bronchitis, bronchiolitis and pneumonia (11). The most frequent symptoms are respiratory (11), (12) ; at the beginning there is fever (present in more than 90% of cases), followed by dry cough (70%). Muscle pain (myalgia), headache, fatigue or tiredness (40%) and digestive symptoms such as vomiting or diarrhea (13), (14) are also frequent at the onset of symptoms. Sore throat seems to be less frequent. Because other respiratory illnesses may present similar symptoms, it is important that the patient report possible contacts with ill persons or persons who have been in areas identified as having a high frequency of coronavirus (15). Monitoring and commu-nication with the medical team is essential to detect respiratory distress early (16).

The new coronavirus (2019-nCoV) identified on December 31, 2019, in Wuhan, China, currently officialized as SARS-CoV2, produces COVID-19. In addition, this virus is the first of its family to be declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (17). Global epi-demiological 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 (18), (19), (20). According to the Research Group Mathematical Models in Science and Technology: Development, Analysis, Numerical Simulation and Control (MOMAT) of the Institute of Inter-disciplinary Mathematics of the Complutense Uni-versity of Madrid, Spain, the application of the Be-CoDiS (Between-Countries Disease Spread) model in the analysis of the COVID-19 pandemic numer-ically projects that this viral phenomenon will be present in the world until July 2020 (21). Therefore, it is important to estimate the trend in the behavior of the epidemiological curve of the COVID-19 pandemic.

The objective of the study was to mathematically model a set of parameters of the pandemic/COVID-19 (deaths, critical, severe, confirmed and new cases) in the municipality of Santa Clara and Cuba by means of the methodology of the Regressive Objective Regression (ROR).

2 | METHODS

The study used pandemic data on deaths, severe and critical cases for Cuba and confirmed cases for the municipality of Santa Clara, Villa Clara province (Figure 1).

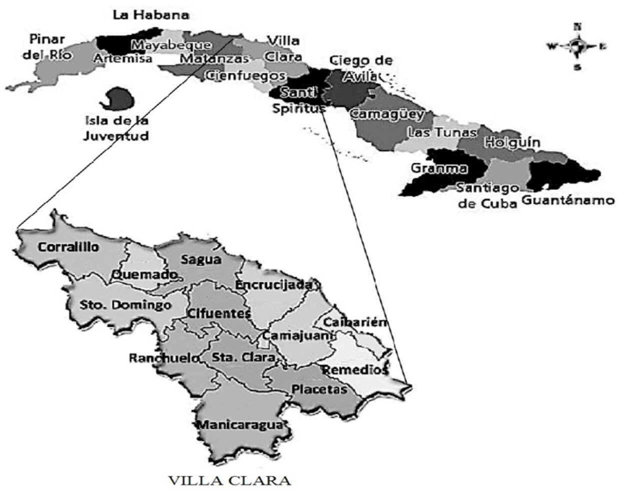

Fig. 1: *Political administrative map of Cuba and Villa Clara province*

The prognosis was carried out using the method-ology of Regressive Objective Regression (ROR) which has been implemented in different variables such as viruses and bacteria circulating in Villa Clara province (22), (23) , (24), (25).

Objective Regressive Regression (ORR) modeling is based on a combination of Dummy variables with ARIMA modeling, where only two Dummy variables are created and the tendency of the series is obtained. It requires few cases to be used and also allows using exogenous variables that make it possible to model and forecast in the long term, depending on the exogenous variable; it has given better results than ARIMA in some variables, such as HIV modeling, entities of viral etiology/arbovirosis and parasitic entities (26), (27),(28), (29).

In the ROR methodology, in a first step, dichotomous variables DS, DI and NoC are created, where:

NoC: Number of cases in the base,

DS = 1, if NoC is odd; DI = 0, if NoC is even, when DI=1, DS=0 and vice versa.

Subsequently, the module corresponding to the Regression analysis of the statistical package SPSS version 19.0 (IBM Company) is executed, specifically the ENTER method where the predicted variable and the ERROR are obtained.

Then the auto correlograms of the variable ERROR will be obtained, paying attention to the maximums of the significant partial auto correlations PACF. The new variables are then calculated according to the significant Lag of the PACF. Finally, these regressed variables are included in the new regression in a process of successive approximations until a white noise in the regression errors is obtained.

The data runs are made until April 23, 2020, according to data taken from the work published in the local newspaper of Villa Clara (30) , which in turn used the source of the Ministry of Health of Cuba (MINSAP). Up to the date of the research, there were 3 393 persons admitted to hospitals for clinical epidemiological surveillance to COVID-19; 6 727 persons were monitored in their homes from primary health care, with 1 283 confirmed cases with the virus, 69% were active cases and 36% were closed cases. All the analysis was performed with the help of the statistical package SPSS, Version 19, of the IBM company.

Ethical aspects

The research was subject to ethical standards, where all the information collected and provided was used only for the stated purpose. It did not involve physical or psychological affectations, in order to be able to generate new knowledge without violating the ethical principles established for these cases. On the other hand, all authors involved in the research, publication and dissemination of the results are responsible for the reliability and accuracy of the results shown (31) .

3 | RESULTS

The results of the deaths in Cuba according to the ROR methodology are shown below (Table 1), which explains 88.9% of the deaths in Cuba with an error of 1.143 cases.

Table 1: *ROR model of deaths in Cuba.*

Summary of the model[c,d]

Model	R	R squared[b]	Adjusted R squared	Standard error of estimation	Durbin-Watson
1	.889[a]	.790	.753	1.143	1.977

a. Variables predictoras: Lag14Fallecidos, DI, DS, NoC

b. Para la regresión a través del origen (el modelo sin término de intersección), R cuadrado mide la proporción de la variabilidad de la variable dependiente explicado por la regresión a través del origen. NO SE PUEDE comparar lo anterior con la R cuadrado para los modelos que incluyen una intersección.

c. Variable dependiente: Fallecidos

d. Regresión lineal a través del origen

Table 2 shows the model obtained according to ROR, the trend is positive and significant at 99%; the other parameters contribute variance explained to the model, although they are not significant. This model depends on the deaths 14 days ago, and the value has a negative value, which indicates that from 14 days until now, the trend of deaths is negative or decreasing, which indicates that the procedures in the care rooms of these patients is highly valued.

Table 2: *Coefficients of the ROR model of deaths for Cuba.*

Coefficients[a,b]

Model		Unstandardized coefficients B	Unstandardized coefficients Standard error	Typified coefficients Beta	t	Sig.
1	DS	-.631	.860	-.190	-.734	.470
	DI	-1.279	.918	-.400	-1.394	.177
	Tendency	.110	.032	1.575	3.465	.002
	Lag14Deceased	-.622	.268	-.416	-2.318	.030

a. Dependent variable: Fatalities

b. Linear regression through the origin

Next, a forecast of the deceased was made (Figure 2), as can be seen there are ups and downs that the model describes with certainty.

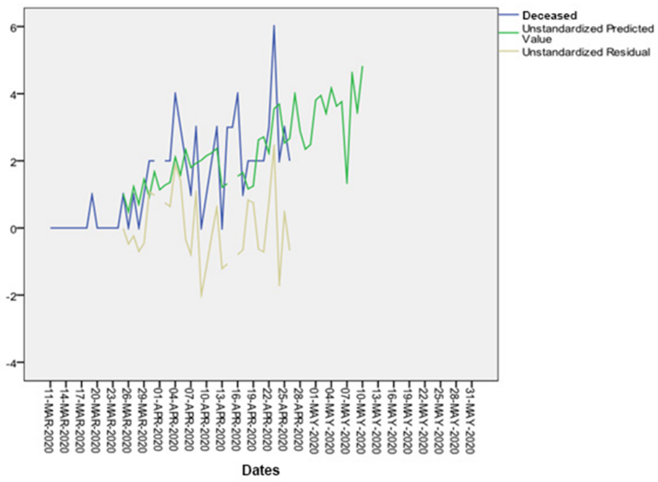

Fig. 2: *Deaths forecast for the next 14 days*

For critically ill patients, the model explains 96.4% of the variance with an error of 1.98 cases (Table 3).

Tabla 3: *Resultados del modelo para casos graves en Cuba por COVID-19.*

Summary of the model[c,d]

Model	R	R squared[b]	Ajusted R squared	Standard error of estimation	Durbin-Watson
1	.964[a]	.930	.911	1.982	1.237

a. Predictor variables: Lag6Graves, DI, DS, NoC.
b. For regression through the origin (the model without an intersection term), R-squared measures the proportion of the variability of the dependent variable explained by regression through the origin. The above CANNOT be compared with R-squared for models that include an intersection.
c. Dependent variable: Graves
d. Linear regression through the origin

The model of severe cases depends on the cases six days ago (Lag6Graves) and shows an increasing trend, although not significant (Table 4). As is known, DS and DI are parameters that describe the ups and downs of the series and keep the data within a certain range.

Table 4: *Model of severe cases in Cuba by COVID-19.*

Coefficients[a,b]

Model		Unstandardized coefficients B	Unstandardized coefficients Standard error	Typified coefficients Beta	t	Sig.
1	DS	6.015	3.605	.657	1.669	.116
	DI	4.852	3.716	.502	1.306	.211
	Tendency	.075	.123	.435	.612	.550
	Lag6Graves	-.335	.294	-.317	-1.138	.273

a. Dependent variable: Graves
b. Linear regression through the origin

Figure 3 shows the forecast of severe cases for the next six days, with a slight increase in the next few days, which leads to take measures in hospitals that attend this group of cases.

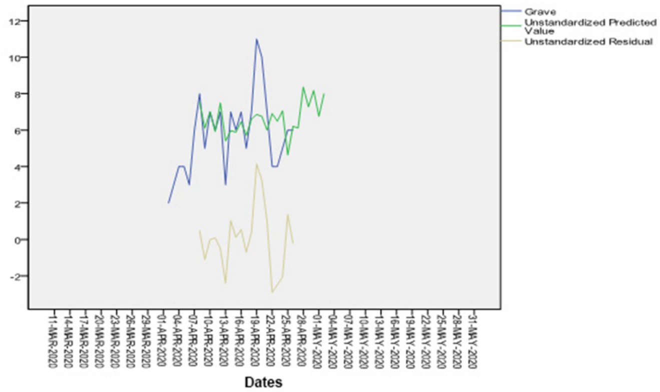

Fig. 3: *Severe weather forecast for the next six days*

Results for the critical cases of Cuba according to the ROR methodology

This model explains 98.3 % of the cases with an error of 1.73 cases, this model depends on the critical cases four days ago (Lag4Criticos) and presents a tendency to decrease, which indicates a good work of the medical teams and an effective work with this type of patients (Table 5).

Table 5: *ROR model for Cuba for critical cases.*

Coefficients[a,b]

Model		Unstandardized coefficients B	Unstandardized coefficients Standard error	Typified coefficients Beta	t	Sig.
1	DS	13.441	2.699	1.154	4.979	.000
	DI	13.939	2.758	1.142	5.054	.000
	Tendency	-.046	.066	-.204	-.696	.496
	Lag4 Critics	-.442	.253	-.452	-1.747	.099

a. Dependent variable: Critics
b. Linear regression through the origin

Next, the forecast for the next four days is shown (Figure 4). There is a small rise.

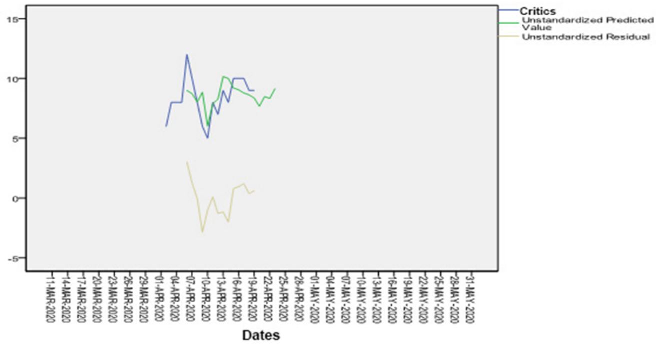

Fig. 4: *Forecast of critical cases for the next four days*

Results of new cases in Cuba

The long-term model for Cuba, particularly the new cases, shows that the model explains 98% with an error of 9.47 cases, the Durbin Watson statistic is close to 2, so we are dealing with a model where the errors are white noise and can be considered a good model (Table 6).

Table 6: *Long-term model for confirmed cases of COVID-19 in Cuba.*

Summary of the model [c,d]

Modelo	R	R squared[b]	Adjusted R-squared	Standard error of estimation	Durbin-Watson
1	.980[a]	.961	.953	9.4708	1.289

a. Predictors: STEP, DI, DS, Lag15New, 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: New
d. Linear regression through the origin

The model and its parameters are shown below, this depends on the cases 15 days ago (Lag15 New) and the variable stage that represents the two stages in which the pandemic has manifested itself in Cuba, before April 16 etape takes the value of zero and after April 16 takes the value of 1 so that if inclusion brings an increase of 30 cases, as can be seen, the tendency is to decrease, although it is not significant yet, DS and DI are variables of the model that capture the ups and downs of the series and maintain in stable parameters the future prognoses (Table 7).

Table 7: *Model with its parameters that capture the ups and downs of the series for new cases.*

Coefficients[a,b]

Model		Unstandardized coefficients B	Unstandardized coefficients Standard error	Standardized coefficients Beta	t	Sig.
1	DS	34.855	13.529	.563	2.576	.016
	DI	29.552	12.285	.477	2.406	.023
	Tendency	-.195	.611	-.146	-.319	.752
	Lag15News	-.180	.231	-.116	-.778	.443
	STEP	30.412	6.592	.549	4.613	.000

a. Dependent variable: New

b. Linear regression through the origin

The trend in new cases is also downward in -0.195 cases, although statistically not significant.

Finally, the long-term prognosis for new cases of COVID-19 in Cuba is shown. As can be seen, there is a decrease in the number of new cases, which indicates that the maximum number of cases in the series may have already been reached on April 17. If the government continues with the physical and social isolation measures, as well as the hygienic, sanitary and personal protection measures, this decrease could continue to decline until it disappears, which is why precautions must be taken to ensure that new cases continue to decrease and disappear more clearly (Figure 5).

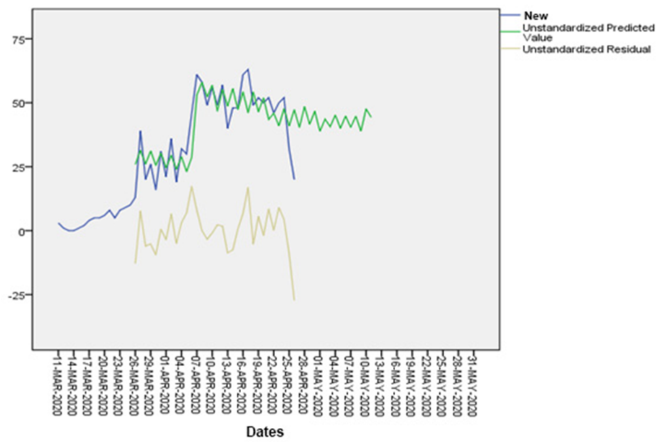

Fig. 5: *Long-term prognosis of new cases of COVID-19 in Cuba*

Results for the municipality of Santa Clara

The long-term model for the municipality of Santa Clara explains 96.8% with an error of 1.76 cases, the Durbin Watson statistic is close to 2, so we are dealing with a model where the errors are white noise and can be considered a good model (Table 8).

Table 8: *Long-term model for confirmed cases of COVID-19 in Santa Clara municipality.*

Summary of the model[c,d]					
Model	R	R squared[d]	Adjusted R squared	Standard error of estimation	Durbin-Watson
1	.969[a]	.938	.919	1.769	1.752

a. Predictors: Step38, Step36, Step37, Step17, Step27, Lag10CONFIRMED, DI, DS, NoC
b. For the 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: Confirmed
d. Linear regression through the origin

The model parameters for confirmed COVID-19 in Santa Clara are shown below (Table 9).

Table 9: *COVID-19 confirmed model according to ROR methodology for Santa Clara municipality.*

Coefficients[a,b]						
		Unstandardized coefficients		Standardized coefficients	t	Sig.
Model		B	Standard error	Beta		
1	DS	-1.489	.981	-.169	-1.518	.140
	DI	-1.617	.970	-.184	-1.668	.106
	Tendency	.118	.032	.595	3.648	.001
	Step27	2,275	1.836	.059	1.239	.225
	Step17	4.486	1.856	.117	2.418	.022
	Lag10CONFIRMED	-.193	.063	-.186	-3.077	.005
	Step37	25.711	1.838	.669	13.988	.000
	Step36	13.377	1.850	.348	7.232	.000
	Step38	12.108	1.836	.315	6.594	.000

a. Dependent variable: Confirmed
b. Linear regression through the origin

It is necessary to wait until May 6 to see if another maximum peak is not obtained; that is, the maximum of cases, and therefore, the confirmed cases disappear, but even so, physical and social isolation measures must be maintained until the cases decrease to zero for two consecutive periods of 10 days; otherwise, the maximum of confirmed cases will have been reached on April 16. It is necessary to wait until May 6 to see if it has been obtained. The model depends on the cases confirmed 10 days ago (Lag10Confirmed) and presents a slightly increasing trend, the Step variables correspond to the number of cases that have been significant throughout the process of the series, for example, Step 17 corresponds to the case on the 17th day after the disease started and so on.

Finally, the long-term prognosis for confirmed cases of COVID-19 in the municipality of Santa Clara is shown (Figure 6).

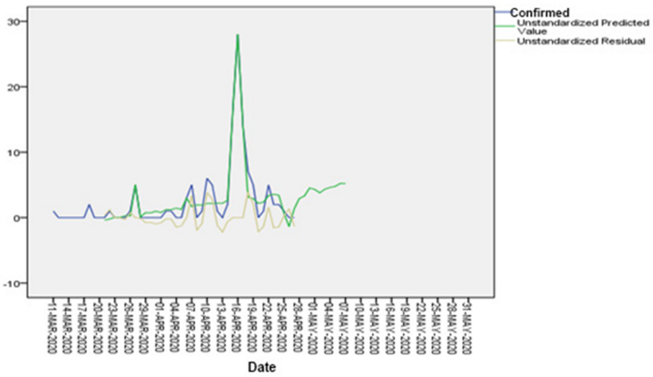

Fig. 6: *Long-term forecast of confirmed COVID-19 cases in Santa Clara municipality as of April 28 through May 7, 2020*

4 | DISCUSSION

When analyzing the long-term model 10 days in advance (this model explains 88.5% of the cases), we can see that all the isolation measures have had a positive effect and the process has behaved as predicted by the mathematical model; or better, the mathematical model has followed what happens in reality, so this is the most important result, which coincides with results obtained in previous years for other entities and living organisms (32), (33), (34). Everything seems to indicate that this pandemic is closely related to climatic variables, and something very important to take into account is that the maximum temperature is increasing and the cases are decreasing with respect to the peak of 8, which has been corroborated in investigations carried out in previous years for other entities and the ARIs them selves (23), (24), (33).It is necessary to carry out studies correlating data on meteorological variables or the behavior of ARI at the national level to see how they behave, which could give a better understanding of the pandemic and its control.

The research shows a decrease in the number of new cases, which indicates that the maximum number of cases in the series may have been reached on May 1st and not on April 17th, which was also a peak, so that if the hygienic and sanitary measures and the physical and social distancing measures taken by the government continue, this decrease could continue to decline until its definitive control; This is why all precautions and strict compliance with all measures must be taken in a sustained manner, so that new cases continue to decrease and disappear more clearly, which has been successfully applied in Cuba, not only for the control of entities of viral, bacterial and parasitic etiology, but also in those involving vector organisms (6),(24),(33),(34),(35).

5 | CONCLUSION

It is concluded that COVID-19, despite being a new disease in the world, can be followed by means of ROR modeling, which allows reducing the number of deceased, severe and critical patients, for a better management of the pandemic.

Conflict of interest

The authors express that there is no conflict of interest.

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