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RESEARCH ARTICLE

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Objective Regressive Regression Methodology: Potential Applications in the Medical Sciences

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ABSTRACT

The possibility of having a methodology that allows the modelling and prediction in the short, medium and long term of biological, social, natural disaster processes and/or phenomena, as well as different infectious entities, constitutes something great. The objective of the research consisted of demonstrating the potential and real capacity of application of the methodology of the Regressive Objective Regression (ROR) in the field of medical sciences. In the ROR methodology, dichotomous variables DS, DI and NoC are created in a first step. Then the module corresponding to the Regression analysis of the SPSS statistical package (ENTER method) is executed, where the predicted variable and the ERROR are obtained; subsequently, the autocorrelograms of the ERROR variable are obtained, paying attention to the maximums of the significant partial autocorrelations, and the new variables are 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 white noise is obtained. Wide possibilities of modelling and forecasting in the short, medium and long term, which go beyond the modelling of infectious entities of parasitic, bacterial, fungal and viral etiology, Acute Respiratory Infections, Acute Bronchial Asthma crises, forecasting of extreme meteorological disturbances, among many others. It is concluded that the ROR methodology has demonstrated potential and real capabilities of application in different fields and branches of science, and therefore constitutes a novel contribution to the science of modelling and forecasting variables to know the future, as well as the impact that different variables contribute to an event or phenomenon, and as it is universal, it can be applied anywhere in the universe.

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Introduction

Throughout history, humanity has suffered the scourge of potentially fatal viral and parasitic diseases, among which Yellow Fever, Dengue, Zika, Chikungunya and Malaria stand out; In most of them, a mosquito (Diptera: Culicidae) is often used as a common factor [1,2]. These diseases are widespread in the tropics, with local variations in risk largely dependent on rainfall, temperature, and rapid unplanned urbanization, among others [3,4].

To these problems are now added the warming of the planet and the intensification of extreme meteorological disturbances, which has brought about changes in the behavior of diseases and their transmissions, with the establishment of vector species in places never before recorded [5-7].

Efforts to control vector-borne diseases have been impeded in part by the development of drug-resistant etiological agents, mosquitoes resistant to insecticides, environmental pollution, the residual effect of chemical substances, the high prices of insecticides in the market, operational failures, abandonment of vector control programs, among other causes [8].

Despite the efforts and resources that have been put into controlling disease-transmitting mosquitoes, their control has not yet been achieved; On the contrary, the emergence of resistance and the development of defense mechanisms against the growing use of insecticides used for their control is becoming much more evident [9-12].

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The increase in diseases transmitted by vector organisms increasingly commits the scientific community to prioritize the search for control alternatives that are much more efficient, economical, feasible and sustainable over time, where the use of modeling stands out in recent decades, the mathematics, which has been applied in different fields of study [13,14]. About 77 equations are known referring to sigmoidal growth models, which are used in epidemics, bioassays, agriculture, engineering fields, tree diameter, forest height distribution, etc., and where cumulative growth models over time have played an important role, as have many researchers who have contributed to the knowledge of relevant developed models , with emphasis on some non-linear models, among the most common are (Gompertz, Weibull, negative exponential, Richard model (logistic, mono-molecular), Brody, Mitcherlich, von Betalanffy. S-Shaped, among others [13-18].

There is the possibility of making forecasts of high quality, precision and certainty using several methodologies, among which the Regressive Objective Regression (ROR) methodology stands out, which due to its simplicity and accuracy can open a window important to know the future of climatic variables or daily data, years in advance and even many more [19-24]. This cycle can extend to the 11 years of the solar cycle, or to higher cycles that are known in nature. The population dynamics of mollusks and insects can also be modeled, such as culicids and their interactions with certain environmental variables, with the aim of establishing prophylactic and timely control measures in epidemiological surveillance programs [24-26]. Consequently, there is a growing need to develop and implement other strategies and alternatives for the control of infectious entities and their vector organisms, which can complement existing methods in a more effective and efficient way.

The objective of the research consisted of demonstrating the potential and real capacity of application of the methodology of the Regressive Objective Regression (ROR) in the field of medical sciences.

Materials and Methods

A synthesized compendium-type discussion was carried out of the main results obtained and published, from 2012 to 2022 related to the application of the ROR methodology in five fronts/lines of research:

- The ROR methodology based on the control of mosquito populations
- The ROR methodology and its impact on river and terrestrial malacofauna with veterinary medical interest
- The ROR methodology and its application to transmissible infectious entities
- The ROR methodology applied to Acute Respiratory Infections and Bronchial Asthma Crisis
- The ROR vs COVID-19 methodology

The ROR (Regressive Objective Regression) methodology [19], for which dichotomous variables DS, DI and NoC are created in a first step, where:

NoC: Number of base cases,

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 SPSS statistical package version 19.0 (IBM Company) is executed, specifically the ENTER method where the predicted variable and the ERROR are obtained.

Then the autocorrelograms of the ERROR variable will be obtained, paying attention to the maximums of the significant PACF partial autocorrelations. The new variables are then calculated taking into account the significant PACF Lag. Finally, these returned variables are included in the new regression in a process of successive approximations until white noise is obtained in the regression errors.

Culicidae

It was possible to model both the general/total and specific larval density (mosquitoes of the genus Anopheles) in the Caibarién municipality and the Villa Clara province and even carry out mathematical modeling in the short, medium and long-term using several models [20,27]. Mathematical modeling of the focality of mosquitoes with atmospheric pressure and some other meteorological variables, as well as the population dynamics of the mosquito species Aedes aegypti with several climatic variables, during the period from 2007 to 2017 in the province of Villa Clara, Cuba [28,29].

It was possible to establish the possible relationship between meteorological variables and the incidence of Dengue in the Villa Clara province, during the years 2017-2020, and to create a predictive model of the behavior of the disease during 2021. Obtaining a correlation of the infectious entity Dengue with the minimum temperature (R=0.332; p=0.023) and water vapor tension (R=0.298; p=0.042), as well as an inverse relationship with atmospheric pressure (R=0.317; p=0.030). The predictive model obtained for 2021 was of high reliability, in which a decrease in the incidence of Dengue is expected in the month of March until the month of July, but after August to December the values will increase greatly [30,31].

Mollusks

Application of the ROR methodology to the modeling and prediction of the infectious entities fasciolosis and angiostrongylosis, specifically to the river and terrestrial malacofauna of the Sancti Spíritus and Villa Clara provinces, with emphasis on the following aspects: influence of some climatic variables on the river malacofauna and terrestrial with zoonotic importance; studies on distribution and abundance of fluvial and terrestrial gastropods with meteorological variables through mathematical modeling, as well as the application of said methodology to the population dynamics of the fluvial and terrestrial malacofauna of both provinces [32-34].

Transmissible Infectious Entities

Application to a group of transmissible infectious entities, both of viral and parasitic etiology (HIV, Leptospirosis, Cholera, Dengue, Chikungunya, Yellow Fever, Zika and Malaria, as the main parasitic entity) [22,23,33].

Acute Respiratory Infections (ARI) and Bronchial Asthma

Mathematical modeling one year in advance for Acute Respiratory Infections (ARI) and Acute Bronchial Asthma Crisis (CAAB), as well as the impact of temperature on the appearance of respiratory infections in birds from a tropical country [20,24,35].

SARS-CoV-2-COVID-19

Application of the ROR methodology to the modeling of SARS-CoV-2, the virus that causes COVID-19, both in the Santa Clara municipality and the Villa Clara province and for Cuba, which allowed us to make short, medium and long forecasts deadline depending on COVID-19. Making forecasts for deaths and new cases with an advance of 105 days in Cuba, as well as forecasts for deaths, critical, severe, confirmed cases and new cases of COVID-19 in the Santa Clara municipality and at the country level; in addition to the application of said methodology based on vaccination against COVID-19 in Cuba, and the comparison of the ROR methodology as a linear model with the non-linear Weibull model for COVID-19 [36-38].

ROR Mathematical Modeling

Simulation tools are appropriate to support decision-making to improve surveillance of vector populations and the risk of transmission of vector-borne diseases [39]. A modeling approach is complementary to experimental and observational approaches, enabling the integration of dispersed and heterogeneous knowledge about the functioning of a complex biological system. By adopting this approach, it is possible to assess the robustness of predictions according to the accuracy of available biological knowledge, thereby identifying the most biased gaps in knowledge and the need for future experiments and observations. In addition, it allows the identification and prioritization of areas and periods where and when surveillance should be focused, under various system operating scenarios. All the results obtained were possible, thanks to the analysis and processing of different databases using the Regressive Objective Regression (ROR) methodology.

Subsequently, the module corresponding to the Regression analysis of the SPSS statistical package version 19.0 (IBM Company) will be executed, specifically the ENTER method where the predicted variable and the ERROR are obtained. Then the autocorrelograms of the ERROR variable are obtained, paying attention to the maximums of the significant PACF partial autocorrelations. The new variables are then calculated taking into account the significant PACF Lag. Finally, these returned variables are included in the new regression in a process of successive approximations until white noise is obtained in the regression errors. The ROR methodology is based on a combination of Dummy variables with ARIMA modeling, where only two Dummy variables are created and the trend of the series is created, it requires few cases to be used and also allows the use of exogenous variables, with the possibility of model and forecast in the short, medium and long term, depending on the exogenous variable; has given better results than ARIMA modeling in some variables.

Results and Discussion

The ROR Methodology Based on the Control of Culicid Larval Populations

A set of monthly data relating to the general and specific larval density (Anopheles) was processed during the period from 2000 to December 2008, for nine municipalities of the Villa Clara province, which allowed us to make forecasts on the aforementioned larval density, in the short, medium and long term, as shown in figures 1 and 2 [40].

Below is the forecast of general larval density (GLD) for the municipalities of the Villa Clara province that were the subject of study in the month of December 2008; The municipalities of Quemado de Güines and Placetas stand out, with high and very high densities respectively, while Caibarién, Manicaragua and Ranchuelo present medium densities and in the rest of the municipalities, the values were low or very low.

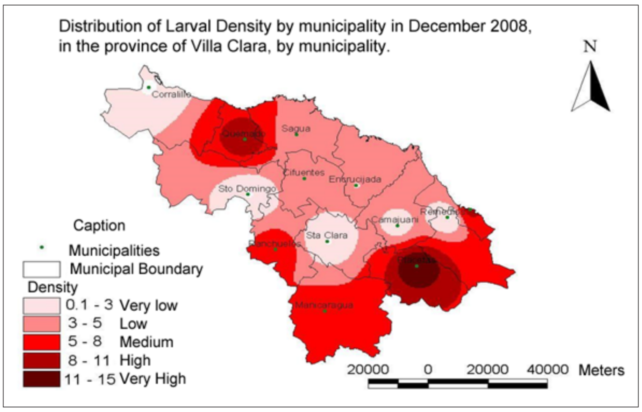

Figure 1: Modeling of General Larval Density for the Month of December 2008

In the case of the anopheline/specific larval density (DLE), this presented very high values in Camajuaní, high in Ranchuelo, while in Placetas there are low values in almost the entire territory, except the central north part of the municipality. In Sagua and the rest of the municipalities, the values were low and very low. It is noteworthy that the Santa Clara municipality, by not providing data, means that the values shown on the map correspond to extrapolations made.

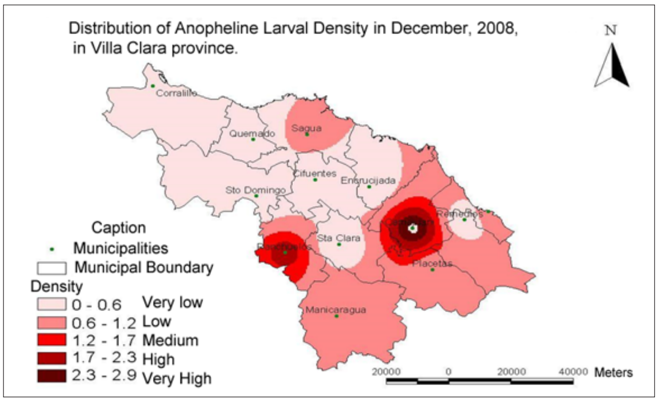

Figure 2: Modeling of Anopheline Larval Density in the Month of December 2008

All of this allowed us to create an Early Warning entomological surveillance system, which allows us to stratify the epidemiological risk in a prophylactic/preventive manner, as well as the preparation of epidemiological bulletins through stratified maps, which results in savings of resources, both materials , economic and human; It should be noted that this collaboration between the UPVLA and the

Provincial Meteorological Center of Villa Clara bore excellent fruit and magnificent results in practice, during the years of implementation of said forecast models (2007-2010).

Modeling of the Equivalent Effective Temperature for the Total Larval Density of Mosquitoes in Caibarién, Villa Clara Province, Cuba

Figure 3 shows the frequency distribution of the residuals following a distribution close to normal, while in figure 4 an almost straight line can be seen in some sections, between the expected probability and the observed probability of the standardized residuals. The actual values and those predicted by ROR modeling of Anopheles Larval Density (DLE) with TEE as an independent variable, coincided during the modeling stage. We can affirm that if the trend continues, then the DLE should continue to decrease in the future in this location. Carried out ARIMA mathematical modeling between 1998 and 2009 that allowed predicting the monthly anopheline larval density in the town of Caibarién, Villa Clara, Cuba, using eight individual climatic variables (average, maximum and minimum temperature, average relative humidity maximum and minimum, precipitation and wind speed) of the Caibarién meteorological station [20]. The monthly anopheline larval density of Villa Clara allows the minimum temperature to be used as a predictor until 2020. Our results show the usefulness of climate information based on an integrated parameter TEE (air temperature, relative humidity and wind speed) to predict the larval density of the Anopheles mosquito in Cuba.

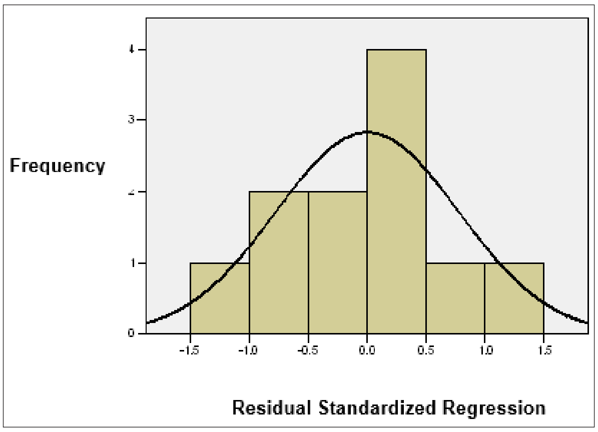

Figure 3: Frequency Distribution of Residuals with ROR (Regressive Objective Regression) for the Larval Density of Anopheles from Caibarién, Cuba

Mean = Average. Sts Dev.= Standard deviation. Average = 1.96 E-15. SD = 0.775. N = 11.

Dependent variable: Anopheles larval density.

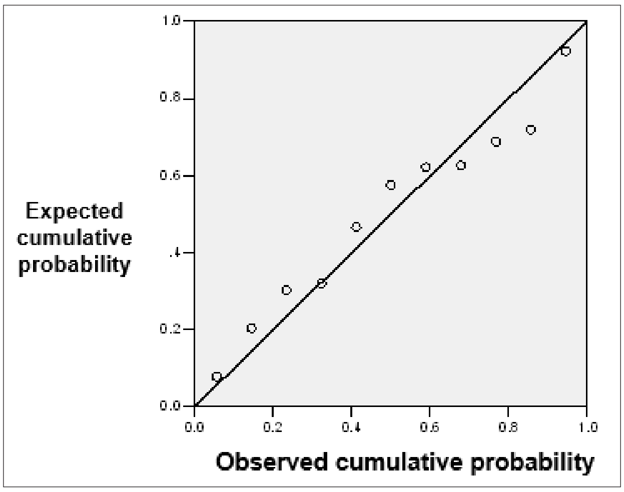

Figure 4: Plot of Probabilities of the Residuals with Regressive Objective Regression (ROR) for the Larval Density of Anopheles in Caibarién, Cuba

The ROR Methodology and its Impact on River and Terrestrial Malacofauna with Veterinary Medical Interest

The objective of the research was to model the bimonthly data series of mollusks for total angiostrongylosis in the province of Villa Clara, Cuba in the period from 2004 to 2015 and to forecast the behavior until 2020 of this entity. through the ROR methodology.

The model for the entity angiostrongylosis was obtained using the ROR methodology which presents an R of 0.96, with an error of 324 ,15. Fisher's F 166.235, significant at 100, this model presents as independent variables the values predicted by the previous returned models. Angiostrongylosis returned in three two-month periods (Lag3angiostot) and the average temperature of the Yabú station, also returned in three two-month periods. The variables DS and DI, which capture the rises and falls of the series, were not significant, as was the trend, but this should not worry us, because we are using predicted variables to predict, which present less variability than the real ones. Angiostrongylosis returned in three two months remains significant at 90% (Table 1). Regarding the NoC trend, this is lower than that reported by other authors [25,27,32,33].

Table 1: Model 3 of Angiostrongylosis for Villa Clara, Cuba Using the Values Predicted by Models 1 and 2 as Independent Variables

Coefficients a, b

Model 3	Lag o retardo	Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	EE	Beta		
DS		11.54	502.62	0.007	0.023	0.98
DI		-35.42	502.57	-0.022	0.070	0.94
NoC		0.22	16.19	0.008	0.014	0.98
Lag3angiostot	Three bimesters	1.05	0.54	0.94	1.19	0.059
Lag3XY1		1.18	20.30	0.02	0.058	0.95

a = Dependent variable = angiostron. b= Regression through the origin. Average temperature (xy1). NoC = Number of cases. Lag = delay. T = Student's t. B and Beta = coefficients of the regression equation. Sig. = significance. SE = Standard error.

It is assumed that the established model is the Dummy model, where the model to be tested is the ROR methodology, observing that for the ROR methodology, it exceeds that of the Dummy variable [27] by 8.03%; Furthermore, the correlation between the real value and the predicted one for the entire series is better in the case of model 3 (ROR methodology, table 2), as can be seen the results are good, here again the ROR methodology presents better results as it is smaller the mean square error and greater correlation. Regarding the improvement of model 3 with ROR with respect to the Dummy variables (8.03%), this is less than the improvement reported from the ROR methodology with respect to ARIMA [25,27,32], which was 46.2%.

Table 2: Statistical Parameters for Comparison with both Methodologies. Model 2 with Dummy and Model 3 with ROR for all Cases

Serie	Mse	Improved Skill (%)	Correlation
Model 2 Dummy	114257	8.03	0.88
Model 3 ROR	105075		0.89

To have a visual idea of the correlation between the real value of total angiostrongylosis and the value predicted by the ROR methodology (model 3), both series were plotted (Figure 5) and a good correspondence was observed. By 2020, values lower than 3000 cases should occur; other works also foresee increases in this case in the larval density of mosquitoes of the genus Anopheles which reinforces the idea that we are in the presence of climate change, which is unequivocal [25,27,33,34,41].

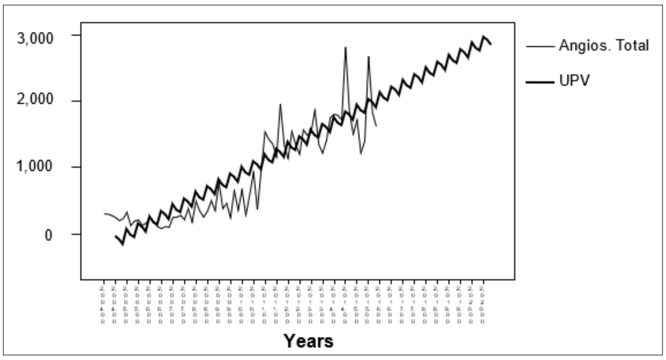

Figure 5: Actual and Predicted Value Until 2020 by Model 3 (ROR) for Villa Clara Total Angiostrongylosis

The ROR Methodology and its Application in Transmissible Infectious Entities

Dengue

Below is the distribution of confirmed Dengue cases in the Villa Clara province during the period from January 2019 to December 2020. It is observed that there is an increasing trend from the month of May to the month of October (Figure 6).

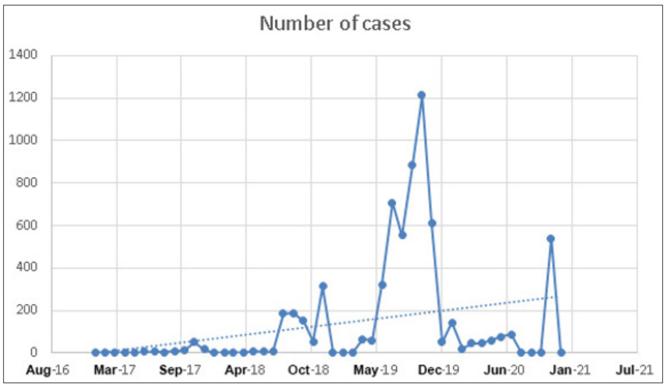

Figure 6: Distribution of Confirmed Dengue cases According to Month of Confirmation. Villa Clara 2017-2020

Source: Overview of notifiable diseases. Villa Clara 2017-2020.

Table 3 shows the distribution of confirmed cases according to the area of residence (January 2017 to December 2020), with 2019 being the year with the highest number of cases, with 4.469, and the municipality of Santa Clara, the year with the highest number of cases. during the entire period studied, with 5.332, which represents 81.90% of the total cases, followed by the Manicaragua municipality, with 203/3.12% and then, the Sagua la Grande municipality (208/3.20%), while the rest of the municipalities presented a smaller number of cases.

Table 3: Distribution of Confirmed Cases According to Municipality of Residence. Villa Clara 2017-2020

Municipalities of Residence	Number of Cases Per Year					Number of Cases Per Year
	2017	2018	2019	2020	Total	
Santa Clara	60	331	4072	869	5332	81.90
Remedios	1	8	13	5	27	0.41
Placetas	2	39	41	23	105	1.61
Caibarién	3	6	12	14	35	0.54
Camajuaní	1	10	67	25	103	1.58
Encrucijada	2	4	18	1	25	0.38
Sagua la Grande	16	162	22	8	208	3.20
Quemado de Güines	2	7	13	0	22	0.34
Santo Domingo	10	128	32	15	185	2.84
Ranchuelo	3	6	38	17	64	0.999
Corralillo	1	23	11	0	35	0.54
Manicaragua	11	58	104	30	203	3.12
Cifuentes	1	129	26	10	166	2.55
Total	113	911	4 469	1017	6 510	100

Source: Overview of notifiable diseases. Villa Clara 2017-2020.

Table 4 shows the calculation of the Pearson correlation coefficient and its statistical significance between the incidence of Dengue cases and the climatological variables; It is noteworthy that there is a significant correlation (r=0.332; p=0.023) between this variable and the Minimum temperature; as these increases, the cases of Dengue fever increase, and in the case of Atmospheric Pressure it is significant (r=-0.317; p=0.030), since as it increases, Dengue cases decrease. Water Vapor Tension was significant (r=-0.298; p=0.042), as it increases, Dengue cases increase. The other variables were not significant.

Table 4: Correlation of Climatological Variables with the Incidence of Dengue Cases. Villa Clara 2017-2020

Climatological Variables	Pearson Correlation	Sig. (Bilateral)
Average temperature	0.268	0.069
Maximum temperature	0.194	0.192
Minimum temperature	0.332	0.023
Maximum relative humidity	-0.123	0.412
Minimum relative humidity	0.155	0.299
Average relative humidity	0.127	0.396
Saturation density	0.002	0.991
atmospheric pressure	-0.317	0.030
Cloudiness	0.079	0.596
Average wind speed	-0.013	0.933
Precipitation	-0.120	0.423
Water Vapor Tension	0.298	0.042

Source: Provincial Meteorological Center and Panorama of notifiable diseases. Villa Clara 2017-2020.

The ROR model in question is formed by the following variables: DS and DI, which are dichotomous variables and the number of Dengue cases in steps back in 1, 2, 8, 10 and 14 months (Lag1Total, Lag2Total, Lag8 Total, Lag10 Total, lag14 Total), also depends on the Tmin returned in 1 month (Lag1Tmin), and on the Precipitation returned in 17 months (Lag17Prec), as this increases, cases of Dengue increase, for example, when the precipitation is 100 mm, the number of Dengue cases increases by 131 cases in the month, the trend was significant to increase in 41 cases. All variables were significant (Table 5).

Table 5: Results of the Application of the ROR model to the Number of Dengue Cases and Some Climatic Variables in Villa Clara

Coefficients a, b

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Standard Error	Beta		
1	DS	-3105.190	439.709	-5.945	-7.062	.000
	DI	-2974.767	431.547	-5.696	-6.893	.000
	Trend	41.202	7.518	3.752	5.480	.000
	Lag1Total	.321	.141	.321	2.285	.033
	Lag2Total	-.447	.143	-.430	-3.132	.005
	Lag8Total	-.458	.142	-.440	-3.212	.004
	Lag10Total	-.577	.137	-.555	-4.229	.000
	Lag14Total	-1.526	.239	-1.038	-6.397	.000
	Lag1Tmin	103.065	16.538	5.845	6.232	.000
	Lag17Prec	1.312	.283	.606	4.637	.000

a. Dependent variable: Total

b. Linear regression through the origin

Malaria

In the case of this research, the objective was aimed at the mathematical modeling of the monthly anopheline larval density (mosquitoes of the genus Anopheles, involved in the transmission of Malaria) in the town of Caibarién, Villa Clara province, Cuba, as well as the linkage with some climatic variables (average, maximum and minimum temperature, average, maximum and minimum relative humidity, precipitation and wind speed), which allow making an adequate forecast in the management of this variable.

The study period spanned from 1998 to 2009 of the 12 years analyzed in the research based on the anopheline larval density for the Caibarién municipality, the month where said density was highest turned out to be October, (with an average density of 2.84 larvae/m2), while the month March was where it behaved lowest (0.38 l/m2 on average).

In the case of the correlation between the DLA and the climate variables, the TN was the one with the highest correlation (0.325), so it was used as a predictor to extend the forecast until 2020; only temperatures (TM, TX and TN) and Precipitation were significant at 99%, while the rest of the variables were not significant (Table 6).

Table 6: Correlations of Climatic Variables with DLA in Caibarién

Variables	TM	TX	TN	HRM	HRX	HRN	Precip.	V.V
Correlation	0.301	0.256	0.325	0.16	0.16	0.11	0.304	-0.14
Signification	0.001	0.004	0.000	0.07	0.07	0.20	0.001	0.097

Finally, the long-term model was extended until 2020 (Figure 7), observing that the predicted values of DLA will be above the historical values from February to April, while in January and from May to December, values will be presented below historical averages. It can also be seen that October is the month with the highest historical anopheline larval density.

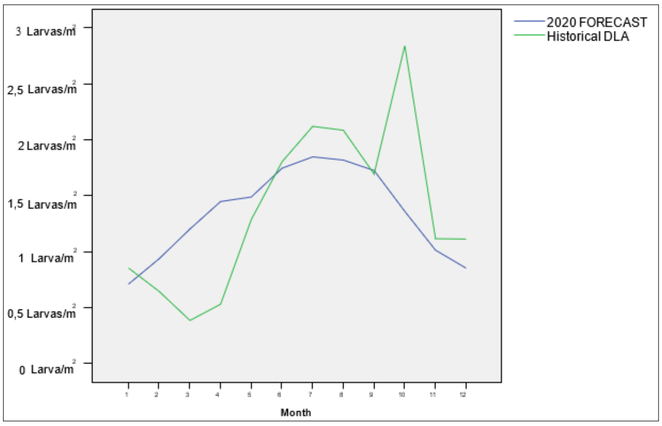

Figure 7: Forecast of Anopheline Larval Density Until 2020 and Historical Values

The ROR Methodology Applied to Acute Respiratory Infections and Bronchial Asthma Crisis

Acute Respiratory Infections (ARI) and Acute Bronchial Asthma Attacks (CAAB) are diseases that can be monitored well in advance. In the following work, a forecast is made one year in advance for these two variables, obtaining highly significant correlations and small errors. Daily data from the Sagua La Grande hospital, Villa Clara, Cuba were used, from January 2006 to February 28, 2011. The prediction period or long-term independent sample included March 1, 2010. until March 28, 2011, a total of 365 cases. Modeling was also carried out by first calculating the long-term forecast, where the predicted value was used as a predictor for the short-term model, and the errors were calculated for the independent sample, obtaining an improvement in the errors in the case of the CAAB. the average error decreases, from 18.7 cases to 1.68. It is possible to predict daily ARI and CAAB cases up to a year in advance using the Regressive Objective Regression (ROR) methodology.

The long-term models for IRAs and CAABs in the independent sample are presented (Figures 8 and 9).

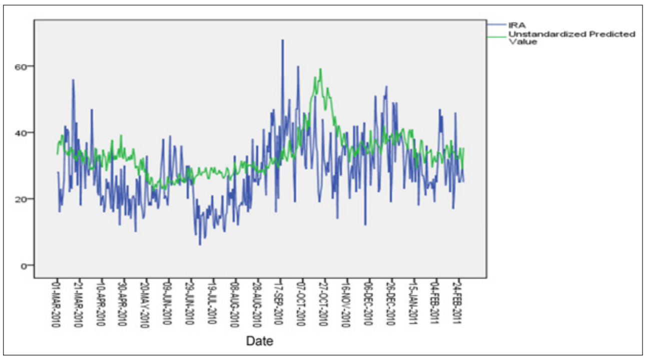

Figure 8: Actual and Predicted Long-Term Value for Independent Ira Sample

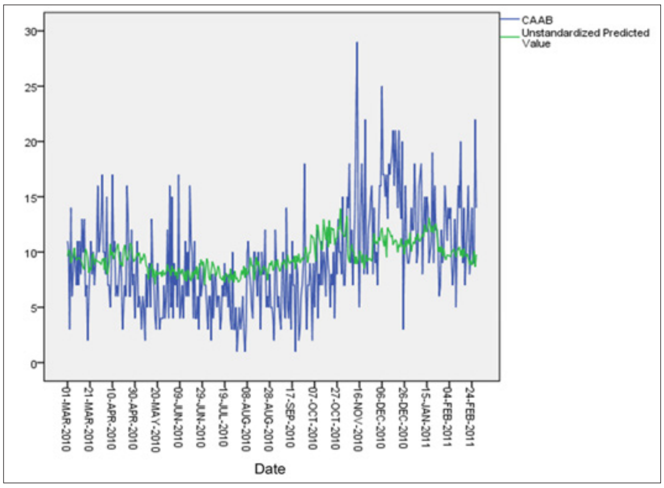

Figure 9: Actual and Predicted Long-Term Value for Independent Sample of CAAB

The correlation between predicted value and the independent sample for CAAB was 0.384, significant at 99%. This prediction method for daily CAABs one year in advance exceeds that obtained by other authors [22,40,42,43] by six months, which was six months in the case of municipal CAABs that logically presented less variability and used Dummy variables (false), our method also surpasses other previous works [44], where municipal data were also used six months in advance, even further back. over time, models had been obtained that predicted four months in advance, but these referred to monthly values of CAAB [22,34,43], here they are also are surpassed by our results, it is also our conviction that the CAAB and the IRA can be estimated on the daily scale 11 years in advance and even more, just like the three-hourly atmospheric pressure [34].

It should be noted that IRAs have a higher mean value than CAAB, as well as greater variability around the mean values, since their standard deviation is 14.6 while that of CAAB is 5.7 (Table 7).

Table 7: Results of the Descriptive Statistics for IRAs and CAABs

Descriptive Statistics

	N	Minimum	Max.	Media	Typ. dev.
IRA	1551	4	130	32.07	14.661
CAAB	1551	0	38	10.64	5.747
N valid (according to list)	1551				

Modeling was also carried out by first calculating the long-term forecast, where the predicted value was used as a predictor for the short-term model, and the errors were calculated for the independent sample. Figure 10 shows the long-term model for IRAs and figure 11 shows the long-term model for CAABs in the independent sample. The correlation between the actual and the predicted value of long-term IRA was 0.321, significant at 99%, while the correlation between the predicted value and the independent sample for the CAAB was also significant (0.388/99%).

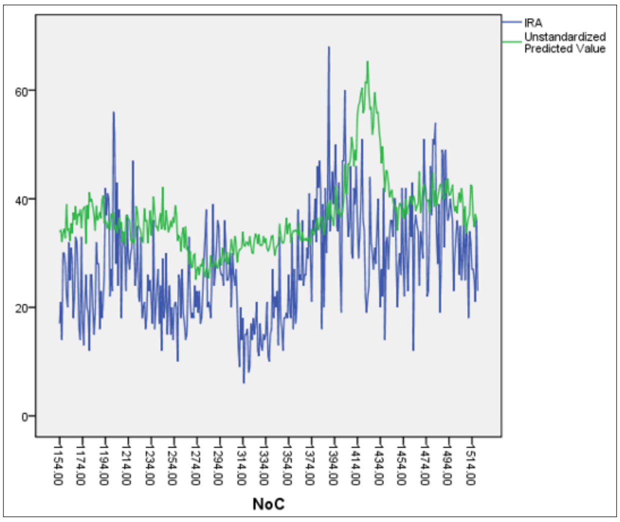

Figure 10: Actual and Predicted Long-Term value for Independent IRA Sample

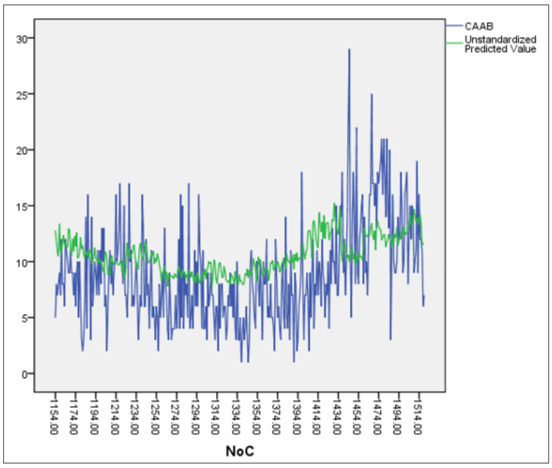

Figure 11: Actual and Predicted Long-Term Value for Independent Sample of CAAB

We can conclude that good results are obtained in the long-term forecast of IRAs and CAABs, since the correlations between the real and predicted values are highly significant, as well as the errors, which are small; Furthermore, by using the long-term forecast first, and then the short-term model, the errors for the CAAB are considerably improved. This form of long-term modeling is a powerful tool to prevent these diseases in advance.

ROR vs COVID-19 Methodology

Below, the results of the deaths in Cuba are reflected according to the ROR methodology (Table 8), where 88.9% of the deaths for Cuba are explained with an error of 1.143 cases.

Table 8: ROR Model of Deaths in Cuba

Model Summary[c, d]

Model	R	R squareb	R square corrected	Standard error of estimation	Durbin-Watson
1	.889a	.790	.753	1.143	1.977

to. Predictor variables: Lag14Deceased, DI, DS, NoC

b. For regression through the origin (the model without intercept term), R square measures the proportion of the variability of the dependent variable explained by regression through the origin. You CANNOT compare the above to R-squared for models that include an intercept.

c. Dependent variable: Deaths

d. Linear regression through the origin

Table 9 shows the model obtained according to ROR; The trend is positive, significant at 99%, the other parameters contribute explained variance 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, that is, a decrease, so the procedures in the treatment rooms care for these patients is highly valued. The model of serious cases depends on cases six days ago (Lag6Graves) and presents an increasing trend, although not significant. 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 9: Model of serious cases in Cuba due to COVID-19

Coefficients[a,b]

Model		Unstandardized coefficients		Typified coefficients	t	Sig.
		B	Standard Error	Beta		
1	DS	6.015	3.605	.657	1.669	.116
	DI	4.852	3.716	.502	1.306	.211
	Trend	.075	.123	.435	.612	.550
	Lag6Severe	-.335	.294	-.317	-1.138	.273

a. Dependent Variable: Serious

b. Linear regression through the origin

Figure 12 shows the forecast of serious cases for the next six days; a slight increase is noted in the coming days, which leads to measures being taken in the hospitals that treat this group of cases.

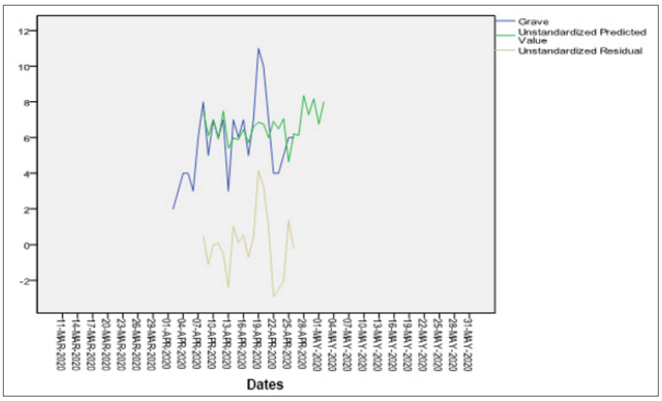

Figure 12: Forecast of Serious Cases for the Next Six Days

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

When analyzing the long-term model ten days in advance (This model explains 88.5% of the cases), where without a doubt, all the isolation measures have had a positive effect and the process has behaved, just as the mathematical model predicted it; or better yet, 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 [24,30,37,45]. 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 cases are decreasing compared to the peak of 8, which has been corroborated in research carried out. in previous years for other entities and the IRAs themselves [22,42,46,47].

The adjusted ROR model predicted that the number of new cases could reach 10.000 (Figure 13), so health and hygiene measures must be intensified, such as the massive, daily and sustained use of masks and social distancing.

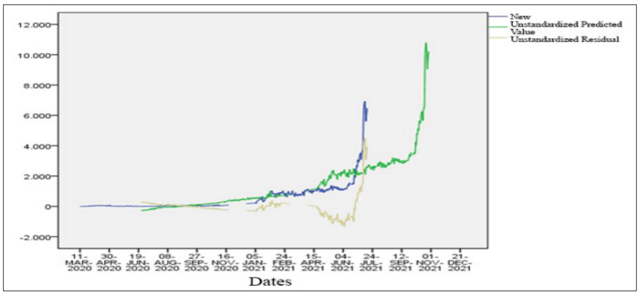

Figure 13: Prediction of New Cases of COVID-19 for Cuba if Hygienic-sanitary measures are not intensified

Vaccination

Figure 14 shows the impact of vaccination on new cases of COVID-19 (using the Cuban vaccine "Abdala"); It is observed that new cases could decrease from October 7, 2021, which is conditioned by the restriction measures and the vaccination rate. The actual cases are higher than the models' prediction (almost 5,000 cases higher), so it is necessary to take severe measures and continue vaccination at the expected pace (Figure 15).

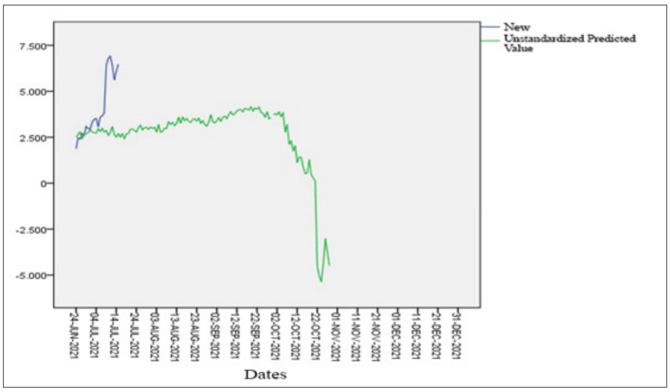

Figure 14: Impact of Vaccination on New Cases of COVID-19 in Cuba

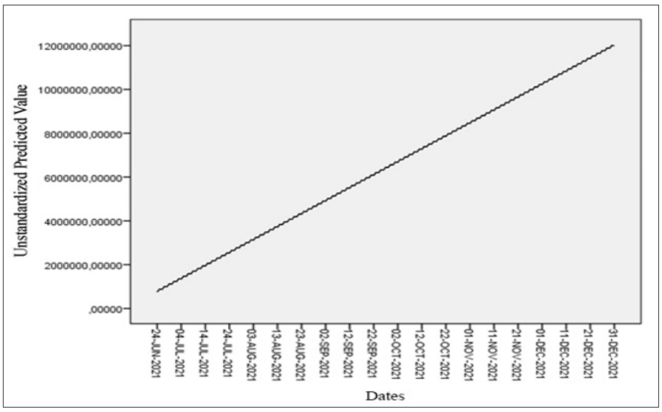

Figure 15: Rhythm that Vaccination should follow (three doses) in Cuba

It is concluded that COVID-19, despite being a new disease in the world, can be monitored, followed, monitored and controlled using the ROR methodology, which allows reducing the number of deceased, serious, critical patients and new cases, as well as better management and management of the pandemic by health authorities. It is necessary to carry out studies where data on meteorological variables or the behavior of IRAs at the National level are correlated to see how they behave, which could provide a better understanding of the pandemic and its control.

Conclusions

The ROR methodology as a linear mathematical methodology has proven potential and real application capabilities in dissimilar fields and branches of medical science. This methodology allows not only to mathematically model mosquito larval densities, as well as the population dynamics of mollusks, but also goes further (possibility of modeling infectious entities of different etiologies (parasitic and viral), such as HIV/AIDS, Cholera, Chikungunya, Dengue, Influenzas, Acute Respiratory Infections (ARI), Acute

Bronchial Asthma Crisis (CAAB), Zika, Angiostrongylosis, Fasciolosis, Malaria and even, in the estimation of the length and area of the universe. The methodology in question constitutes a contribution to the science of modeling and forecasting variables to know the future, as well as the impact of different variables, and what they contribute to an event or phenomenon. Therefore, it is a powerful tool to explain the phenomena of nature and society, since being universal, it can be applied anywhere in the universe.

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