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(Research Article)

Can pandemics be predicted?

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Abstract

Epidemics are global phenomena that need to be prevented in advance to save lives and resources. The objective of the research was to predict in the long term when the next pandemic might occur, and how many deaths it might bring, as well as modeling the pandemics that have struck humanity from 165 AD to the COVID-19 pandemic in 2019. Having a forecast in advance would allow Global Health Organizations, such as PAHO and WHO, to be aware of these predictions, and to take measures in a precise and timely manner, so that this does not happen, and if it does happen, to minimize its consequences as much as possible. The Bubonic Plague has been the Epidemic that has caused the most deaths, with 200 million, where the average value throughout history is 27,792,857; generally, epidemics are below 50 million deaths. In this research, 100% of the cases are explained with zero errors, both for deaths and years of occurrence, where the trend of deaths is increasing, and the model depends on the deaths regressed on 11 events. It was possible to predict the number of deaths, as well as the year of occurrence of possible future global pandemics. Health entities, agencies and bodies (PAHO/WHO) should be aware of these predictions and take measures accordingly.

Keywords: Epidemics; Modeling; Pandemics; Death trends

1. Introduction

There are a large number of natural and even social phenomena in nature whose occurrence, evolution and final result depend on several independent variables (Fimia *et al*., 2021; Osés *et al*., 2021a, b; Arencibia, 2022). Even though all these variables intervene in the phenomenon, some are more important than others and even the interrelation between them plays a very important role (Wynants *et al*., 2020; Osés *et al*., 2021a; Monzón *et al*., 2023). The intervention of several independent variables makes the prediction of the occurrence of a natural phenomenon difficult to quantify (Gupta *et al*., 2020; Wynants *et al*., 2020; Fimia *et al*., 2021; Osés *et al*., 2021a, b; Arencibia, 2022). Predictive techniques have been developed, both in the study of natural phenomena and in social phenomena, each with its scopes and limitations (Gupta *et al*., 2020; Martínez *et al*., 2020; Alves *et al*., 2021; Osés *et al*., 2021a, b; Chirania *et al*., 2023; Soppari *et al*., 2023).

Currently, there are several methods to predict the occurrence of some phenomenon or outcome, which are encompassed in predictive analytics (Xu *et al*., 2014; Espino, 2017; Osés *et al*., 2018 a, b, c; Fimia *et al*., 2019; Fimia *et al*., 2021; Osés *et al*., 2021a, b; Parmeshwar *et al*., 2023; Rashid *et al*., 2023). Predictive analytics is a subdiscipline of

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data analysis that uses statistical techniques, such as computational learning or data mining, to develop models that predict future events or behaviors (Osés *et al*., 2018 b, c; Gupta *et al*., 2020; Osés *et al*., 2021b; Monzón *et al*., 2023; Soppari *et al*., 2023; Rashid *et al*., 2023). These predictive models allow taking advantage of behavioral patterns found in current and historical data to identify risks (Durán and Botello, 2020; Zhao *et al*., 2020; Fimia *et al*., 2021; Osés *et al*., 2021a, b; Marín *et al*., 2020). This type of analysis is based on the identification of relationships between variables in past events, in order to then exploit these relationships and predict possible outcomes in future situations (Osés *et al*., 2016; Osés *et al*., 2018a, c; Fimia *et al*., 2020; Durán and Botello, 2020; Min, 2021; Osés *et al*., 2021a, b; Soppari *et al*., 2023; Rashid *et al*., 2023). Doing this is not straightforward as it must be taken into account that the accuracy of the results obtained depends a lot on how the data analysis has been performed, as well as on the quality of the assumptions (Durán and Botello, 2020; Gupta *et al*., 2020; Zhao & Chen, 2020; Fimia *et al*., 2021; Osés *et al*., 2021a, b; Fuest *et al*., 2023).

Trivially, it might seem that predictive analysis is the same as forecasting (which makes predictions at a macroscopic level), but no, it is something completely different (Durán and Botello, 2020; Min, 2021; Fimia *et al*., 2021; Osés *et al*., 2021a, b). In a crude example, while a forecast can predict how many hurricanes may form in a year, predictive analysis can indicate of what intensity and what time of year they will be most likely to form, and even where (Osés *et al*., 2018 b, c; Osés *et al*., 2021a, b). Therefore, in order to carry out predictive analysis, it is essential to have a large amount of data, both current and past, to be able to establish patterns of behavior and thuś induce knowledge. In the example above, there is more probability of prediction if variations in regional and global temperature, wind direction, changes and sources of pressure change etc., are also considered. This process is accomplished by computational learning. Computers can "learn" autonomously and thus develop new knowledge and capabilities, this requires large databases, and the tools of predictive analysis (Osés & Grau, 2011; Osés *et al*., 2018a, b; Durán & Botello, 2020; Min, 2021; Osés *et al*., 2021a, b).

Currently, there are several techniques applicable to predictive analytics; i) regression, which includes linear, nonlinear, and multivariate adaptive regression; support vectors, ii) computational learning, where neural networks, Naïve Bayes and K-nearest neighbors are included (Soppari *et al*., 2023; Rashid *et al*., 2023). One of these tools is the Objective Regressive Regression method (Osés and Grau, 2011; Gupta *et al*., 2020; Arencibia, 2022), which we will explain briefly below.

The objective of the research consisted of predicting in the long term when the next Global Epidemic might occur, and how many deaths it might bring, as well as modeling the pandemics that have plagued humanity, from 165 AD to the COVID-19 pandemic in 2019, by applying the methodology of Objective Regressive Regression (ORR).

2. Methodology

2.1. The Objective Regressive Regression methodology

For the mathematical modeling of the data, the Objective Regressive Regression (ORR) methodology was used, which has been widely used on different occasions. In the case of the mathematical modeling of the data, the first year shown in the Infographic for the Pandemic in question was used as the starting date, and the total number of deaths was also estimated.

In this methodology, the dichotomous variables DS, DI and NoC must be created first, 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 saw tooth 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.

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 autocorrelograms of the ERROR variable are obtained, paying attention to the maximum of the significant partial autocorrelations (PACF), and then the new variables are calculated, taking into account the significant Lag of the PACF. Finally, these variables are included in the new regression, regressed in a process of successive approximations until a white noise in the regression errors is obtained. In the case of atmospheric pressure, the lags of one year in advance were used.

2.2. About the data used in the research

In this work, data were taken from the Infographic COVID-19 two years later, by Carolina Vilches Monzón, of March 11, 2022 in the "Vanguard" newspaper of Villa Clara province, Cuba, in order to predict in the long term when the next Global Epidemic could occur and how many deaths it could bring with it. Having a forecast in advance would allow Global Health Organizations such as the WHO to be attentive to these predictions and take measures so that this does not happen or try to minimize its consequences.

3. Results and discussion

The number of deaths due to Pandemics throughout history is shown below, according to the database (Figure 1).

The Bubonic Plague was the pandemic that caused the most fatalities, with 200 million deaths, with an average value throughout history of 27 792 857. Generally, Pandemics are below 50 million deaths (Gupta *et al*., 2020; Arencibia, 2022).

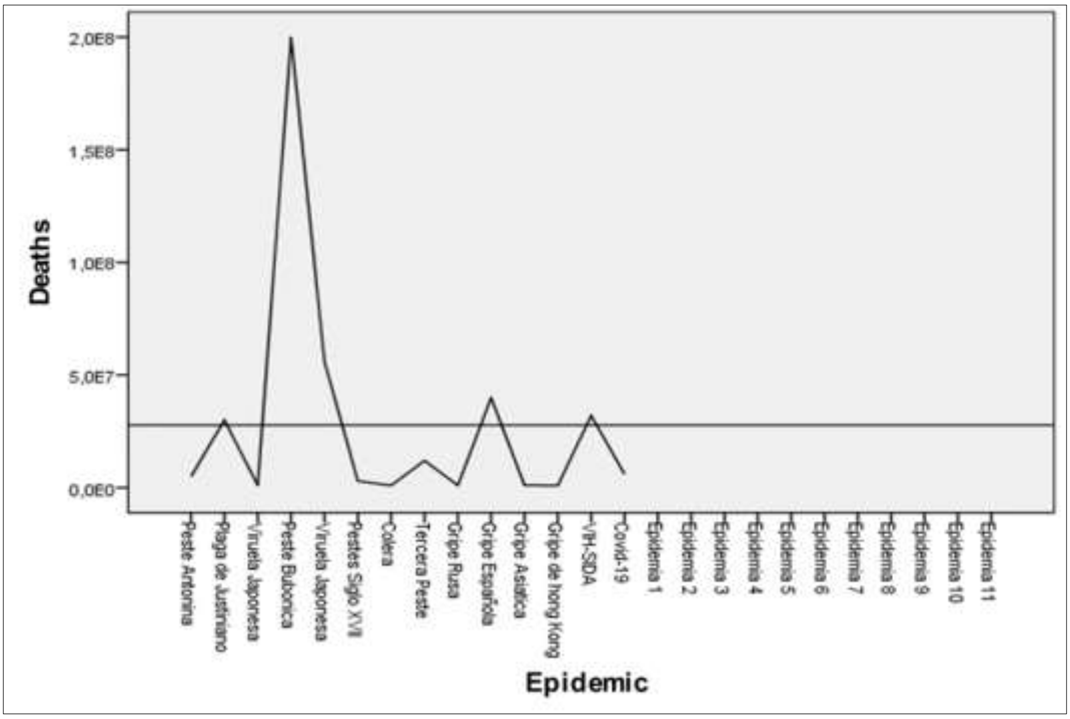

Figure 1 Deaths due to pandemics throughout history

The model in table 1 explains 100 of the cases, where the errors cannot be calculated because the residuals are zero, but the model turned out to be almost perfect.

Table 1 Summary of the ORR model for the deceased

Summary of the model [c, d]					
Model	**R**	**R squared[d]**	**Adjusted R-squared**	**Standard error of estimation**	**Durbin-Watson**
1	1.000[a]	1.000	.	.	0.964

a. Predictors: Lag11Deaths, DI, 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: Deaths; d. Linear regression through the origin

In the case of Fisher's F, it could not be calculated, since the model poses a division by zero that would require the creation of a new statistic to treat it (Osés *et al*., 2015) (Table 2).

Table 2 Model results according to regression and residual application

ANOVA[a,b]						
Model		**Sum of squares**	**gl**	**Quadratic mean**	**F**	**Sig.**
1	Regression	1060999999999999.000	3	353666666666666.700	.	.[c]
	Residue	0.000	0	.		
	Total	1060999999999999.000[d]	3			

a. Dependent variable: Deaths; b. Linear regression through the origin; c. Predictors: Lag11Deaths, DI, NoC; d. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

The model depends on DI (Inverted Sawtooth), where the trend is for increasing deaths, and the model depends on regressed deaths on 11 events (Table 3).

Table 3 Model results according to trend of deaths

Coefficients[a,b]						
Model		**Unstandardized coefficients**		**Standardized coefficients**	**t**	**Sig.**
		B	**Standard error**	**Beta**		
1	DI	-28741071.429	0.000	-1.248	.	.
	Trend	2482142.857	0.000	1.719	.	.
	Lag11Deaths	-0.009	0.000	-0.008	.	.

a. Dependent variable: Deaths; b. Linear regression through the origin

The following is the long-term prognosis (Figure 2). Deaths may reach 62 million if prophylactic, well-targeted and timely measures are not taken against future looming pandemics, which is in line with what has been proposed by other authors in this regard (Osés *et al*., 2021a; Soppari *et al*., 2023; Rashid *et al*., 2023).

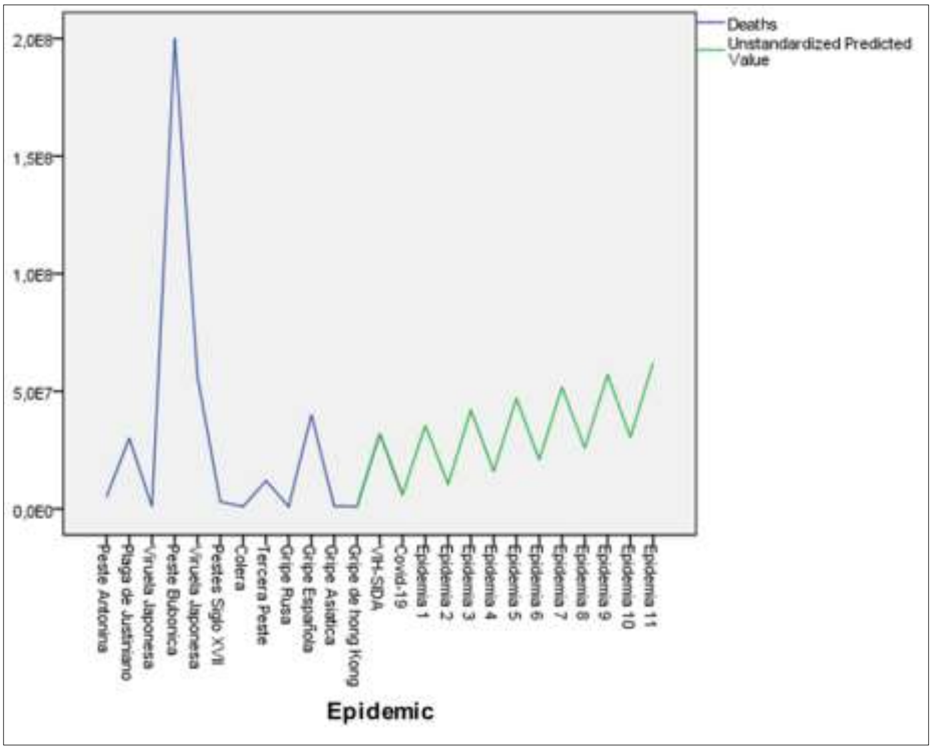

Figure 2 Predicted long-term deaths in the absence of pandemic containment measures

The ROR model was applied for the year of occurrence of the pandemics, obtaining similar results, that is, it explains the 100% of the cases were explained with zero errors. The final model can be seen in Table 4. It depends on SD (Sawtooth), ID (Inverted Sawtooth) and the regressed year in 11 cases. The errors are zero and the Student's T cannot be observed, as well as its significance.

Table 4 Results of the application of the model for the occurrence of future pandemics

Coefficients[a,b]						
Model		**Unstandardized coefficients**		**Standardized coefficients**	**t**	**Sig.**
		B	**Standard error**	**Beta**		
1	DS	1932.595	0.000	0.561	.	.
	DI	1953.237	0.000	0.802	.	.
	Lag11Year	0.089	0.000	0.024	.	.

a. Dependent variable: Year of Occurrence; b. Linear regression through the originIn figure 3, in green the predicted value for the following 11 cases.

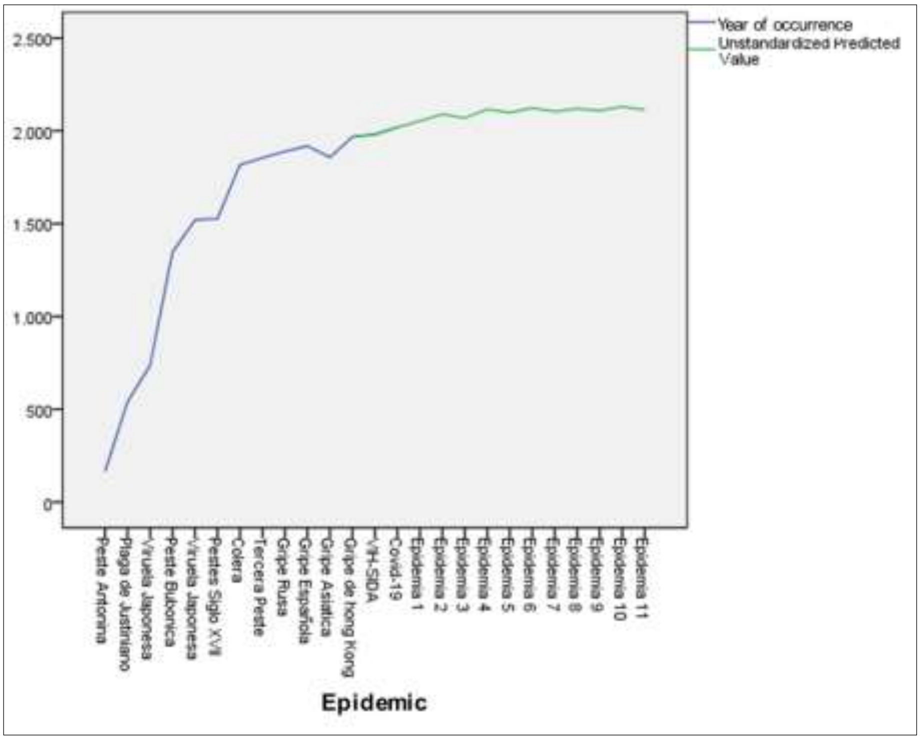

Figure 3 Predicted year for the next 11 cases forward after the last COVID-19 pandemic. Y-axis. Year variable; X-axis. Epidemic Name

Table 5 shows the forecast of the year in which the next pandemics may appear, making it clear that the next pandemic may occur in the year 2053. The values after the dot in the year forecast refer to the approximation obtained with the predicted value; for example, the value 2098.56842 must correspond to the year 2099, since this is the numerical approximation that corresponds according to the mathematical rules.

Table 5 Forecast of the next pandemics to years

		Epidemics	Year of occurrence	Predicted value	Non-standardized residue
1		Antonine Plague	165	.	.
2		Justinian Plague	1541	.	.
3		Japanese smallpox	735	.	.
4		Bubonic Plague	1347	.	.
5		Japanese smallpox	1520	.	.
6		Plague XVII Century	1527	.	.
7		Cholera	1817	.	.
8		Third Plague	1855	.	.
9		Russian Flu	1889	.	.
10		Spanish Flu	1918	.	.
11		Asian Flu	1857	.	.
12		Hong Kong Flu	1968	1968.00000	0.00000
13		HIV/AIDS	1981	1981.00000	0.00000
14		COVID-19	2019	2019.00000	0.00000
15		Epidemic 1	.	2053.11579	.
16		Epidemic 2	.	2089.23684	.
17		Epidemic 3	.	2069.22105	.
18		Epidemic 4	.	2115.81053	.
19		Epidemic 5	.	2098.56842	.
20		Epidemic 6	.	2122.25263	.
21		Epidemic 7	.	2104.20526	.
22		Epidemic 8	.	2119.38947	.
23		Epidemic 9	.	2108.67895	.
24		Epidemic 10	.	2130.48421	.
25		Epidemic 11	.	2113.24211	.
Total	**N**	**25**	**14**	**14**	**3**

Regression analysis is the most widely used statistical technique to investigate or estimate the relationship between dependent variables, and a set of independent explanatory variables. In our environment the ROR methodology has allowed us to mathematically model: a) mosquito larval densities (Osés *et al*., 2012; Osés *et al*., 2014; Osés *et al*., 2016; Osés *et al*., 2018a,b; Fimia *et al*., 2019); b) population dynamics of mollusks; c) modeling of infectious entities of different etiologies, such as HIV/AIDS, Cholera, Influenzas, Acute Respiratory Infections (ARI), COVID-19, Acute Bronchial Asthma Crises (CAAB), Fasciolosis, Angiostrongylosis; d) in the estimation of the length and area of the universe (Wilke *et al*., 2016; Fimia *et al*., 2021; Osés *et al*., 2021a,b; Osés, 2022) monthly forecasting of precipitation and temperature extremes (Osés *et al*., 2018b; Fimia *et al*., 2020a,b); e) weather disturbance forecasting (cold fronts and hurricanes, earthquake latitude and longitude prediction (Osés *et al*., 2018b; Osés *et al*., 2021a,b), information search in white noise (Osés *et al*., 2018b), modeling of the Equivalent Effective Temperature (EET) and Atmospheric Pressure (AP); f) up to the own electricity consumption of a municipality, province and/or nation), and more recently in the COVID-19 pandemic (Osés *et al*., 2016; Fimia *et al*., 2021; Osés *et al*., 2021a).

4. Conclusion

It is possible to predict fairly accurately when the next pandemics will occur using the Objective Regressive Regression methodology.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have declared that no competing interests exist.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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