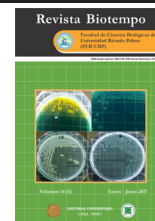




## Biotempo (Lima)



ORIGINAL ARTICLE/ ARTÍCULO ORIGINAL

### IMPACT OF TEMPERATURE IN THE PRESENCE OF RESPIRATORY INFECTIONS OF BIRDS IN A TROPICAL COUNTRY

### IMPACTO DE LA TEMPERATURA EN LA PRESENCIA DE INFECCIONES RESPIRATORIAS DE AVES EN UN PAÍS TROPICAL

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#### ABSTRACT

Retrospective data were used to obtain statistical data on the epizootics of the susceptible and dead due to avian flu in the province of Villa Clara, Cuba in the period 2005-2007. These data were correlated with the average temperatures corresponding to this period in this county. Total deaths were correlated with the total of susceptibles; the latter were correlated in turn with the provincial temperatures. To analyze the data, the Autoregressive Integrated Moving Averages (ARIMA) model of the Box-Jenkins Methodology was used. Techniques of multivariate regression for modeling the total number of poultry deaths were also applied. The final ARIMA model showed that an increase of 1 degree of temperature meant an increase of 53.37 deaths using a 95 % probability value. This work enables corroborating and quantifying the impact of mean temperature on the susceptibility and death in poultry in the study area. With an increase of 1°C of average monthly temperature can be expected an increase of 8894 susceptible cases, and as the susceptible ones increase by 1000, deaths are increased in 6 birds, so that for the susceptible ones for 0.06 will be approximately the same to the total of deaths.

**Keywords:** Climatic impact –avian flu infections – Cuba – temperature

#### RESUMEN

En el trabajo se utilizó la información retrospectiva para obtener los datos estadísticos de la epizootiología de los susceptibles y de las muertes de las infecciones por gripe aviar, de la provincia Villa Clara, Cuba en el período 2005-2007. Estos datos fueron correlacionados con el promedio de temperaturas correspondiente a este período en esta provincia. El total de muertes fue co-

relacionado con el total de las susceptibles; estas últimas se correlacionaron a cambio con las temperaturas provinciales. Para el procesamiento de la información, se utilizó el modelo de Promedios Autoregresivos Integrados (ARIMA) de la Metodología Box-Jenkins. Se emplearon también las técnicas de regresión multivariada para modelar el total de muertes de las aves. El modelo final ARIMA expresó un incremento de 1°C de temperatura, lo cual significó un incremento de 53,37 muertes. También se utilizó un 95 % de valor de probabilidad. Este trabajo permite corroborar y cuantificar el impacto de la temperatura media en las susceptibles y en las muertes de las aves en el área de estudio. Se obtuvo que con 1°C de temperatura media mensual, se pueda esperar un incremento de 8894 casos susceptibles y como estos incrementan en 1000 las muertes, se incrementan en 6 aves, por lo que las susceptibles para 0,06 serán las mismas aproximadamente al total de muertes.

**Palabras clave:** Impacto climático – infección de gripe aviar – Cuba – temperatura

## INTRODUCTION

The cold avian infections stands for a very contagious viral disease caused by the strains type A of the cold virus that can affect to all birds species (Godoy, 2006; Juckett, 2006; Causey & Edwards, 2008; Fuller *et al.*, 2010); although it has enough potential so as to infect to different species of mammals, included the human being, the pig and the cat. In addition to biological and ecological factors, climate factors influence the emergence of infectious diseases (Patz *et al.*, 1996; Sehgal 2010; Si *et al.*, 2010; Herrick *et al.*, 2013; Si *et al.*, 2013).

The highly pathogenic cold avian or the originally named “flow plague” is initially described in Italy in 1878. It was also known as the Lombardy disease. Although Centanni and Savonuzzi in 1901 identified a causing agent of the disease, it was no longer in 1955 when it is described as a virus of the Cold A family, as responsible (Juckett, 2006). The first time the virus was isolated in tern birds in South Africa, in 1961 (Juckett, 2006).

It was traditionally thought the human cold by avian virus was an exceptional fact, but such opinion changed when the outbreaks occurred in the last years; the first one, called “chicken cold”, occurred in 1997 in Hong Kong and it was produced by a virus A (H5N1). Subsequently, there were more outbreaks, once more in Hong Kong in 2002, also by A (H5N1) and in Holland in 2003, by A (H7N7), but among them it is noticeable the present succession of outbreaks by virus A (H5N1) that started in 2003 in the Asian southeast; and now, has the greatest sanitarian interest related to worldwide cold avian (Di Trani *et al.*, 2006; Si *et al.*, 2010; Tsuchihashi *et al.*, 2011; Herrick *et al.*, 2013; Zhang *et al.*, 2014).

The breathing dysfunctions cause a decrease of the production in birds, mainly in those that are confined and subjected to high productive rhythms. Cold avian

infections are among the frequent illnesses (Jaakkola *et al.*, 2014).

One of the interactions among the components of the productive system that most influence is the relationship between the environment and the animal. The environment in which the animal acts is compound primarily of the environmental or climatic factors, which should be structured to offer well-being. The climatic changes and especially the waves of heat, so frequent in the tropic, cause damages so abrupt and sudden, capable to ruin the most enviable productive indexes possible to obtain after an efficient productive task (Zhang *et al.*, 2014).

The modern poultry keeping, as any other industry, has as north of its activity the profitability, and in such a concerned market the producers don't have a different option for the maximum of efficiency; therefore, as the hens express to the maximum the potential productive content in their genetics, it is indispensable to manage an appropriate environment that provides them the appropriate environmental conditions (Gilbert *et al.*, 2008). The temperature, humidity, quality of the air, they are some of the environmental factors to keep in mind during the productive period of the domestic birds (North & Bell, 1990; Causey & Edwards, 2008; Tsuchihashi *et al.*, 2011; Herrick *et al.*, 2013; Si *et al.*, 2013; Jaakkola *et al.*, 2014).

The high temperatures make susceptible of breathing illnesses to the birds, among those the cold avian infections (Gilbert *et al.*, 2008). This is a breathing illness of the domestic hens caused by the bacteria *Haemophilus*. The illness is spread worldwide and causes important economic losses (Blackall, 1999; Shaman *et al.*, 2010). The susceptible birds generally develop the symptoms in the 3 days after the exhibition to the infection. Those



Villa Clara province, in the period 2005 - 2007. These data were correlated with the temperatures stockings average corresponding to this period in this province, contributed by the database of Provincial Center of Meteorology, particularly those of the Department of Applied Meteorology. The total of deaths was correlated with the total of susceptible; these last ones correlated in turn with the temperatures provincial stockings.

**About data processing**

For the information processing, the model Autoregressive Integrated Moving Averages (ARIMA) was

used of Box-Jenkins Methodology through the statistical package SPSS Version 13. Techniques of multivariate regression for modeling the total of poultry deaths were also applied.

**RESULTS AND DISCUSSION**

In Fig. 2, the behavior of the susceptibility of birds is observed for the province, seemingly a marked seasonality is not observed, seeming an aleatory event at first sight with big picks of more than 500 000 birds and a half value 200 000. The biggest value takes place in August 2007, where a near pick is reaching the 600 000 birds in the whole territory. These results coincide with the obtained by Nicholson *et al.* (2003).

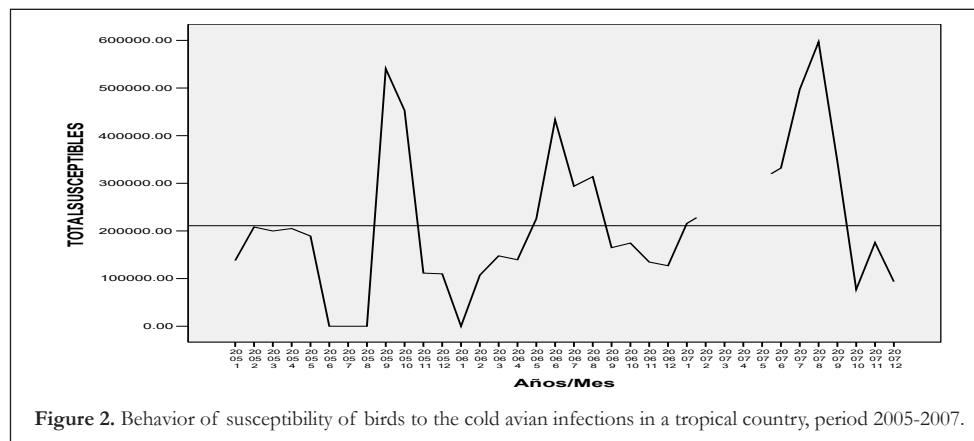


Figure 2. Behavior of susceptibility of birds to the cold avian infections in a tropical country, period 2005-2007.

A process order autoregressive was shown with a spike very different in the autocorrelation of first order the mobile stocking of order 1 was discarded to be a model but expensive and less probable, in figs. 3 and

4 the total and partial autocorrelations are presented. A marked seasonality is not evidenced since it can be only found a spike or column which means a movement order autoregressive.

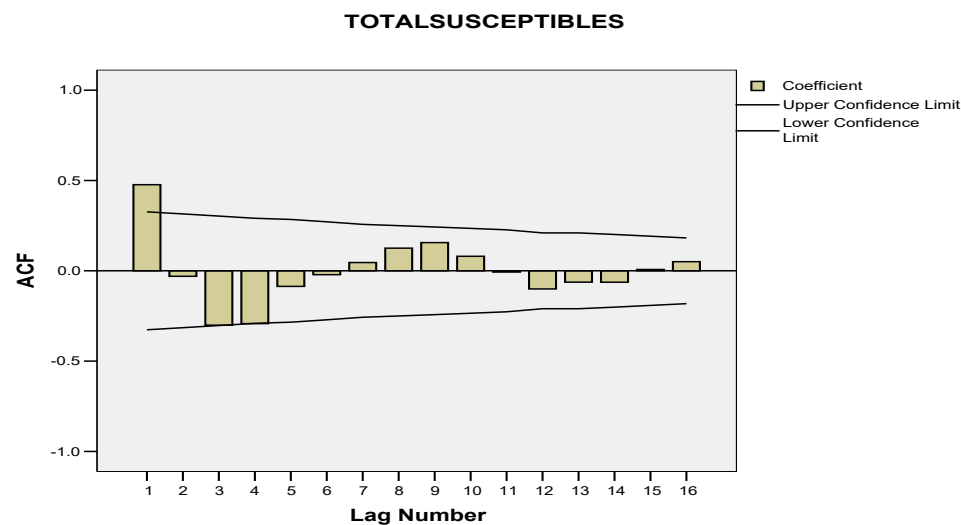
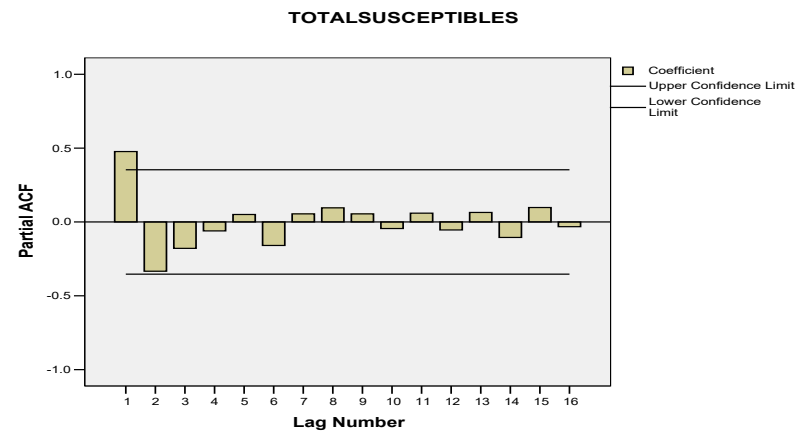


Figure 3. Autocorrelogram Function (ACF) of the series with regression to 1 step of the susceptibility of birds to the cold avian infections in a tropical country, period 2005-2007. Lag Number = delay.



**Figure 4.** Partial Autocorrelogram Function (ACF) of the series with regression to 1 step of the susceptibility of birds to the cold avian Infections in a tropical country, period 2005-2007. Lag Number = delay.

When using the model integrated autoregressive of stockings motives of Box & Jenkins known as modeling ARIMA, the errors of the pattern gave in the order of 138649 cases, in Table 1 can be appreciated the pattern obtained after several steps, being evidenced an order autoregressive significant, and the returned provincial half temperature of one month was included that presented correlation with the variable Susceptibility; being obtained that the parameter is highly significant since the P value is similar to 0.014, smaller than 0.05, therefore it is significant to 95%, coinciding with that outlined by Tsuchihashi *et al.*

(2011) and Osés *et al.* (2012b), who gives a primordial paper to the high temperatures in the susceptibility before the caloric stress in the birds and the presentation of breathing illnesses. Thus, it can be affirmed that with 1°C of monthly mean temperature can be expected an increase of 8894 susceptible cases of the variable temperature for the susceptibility of birds to breathing infections. This result entirely coincides with the obtained by Osés *et al.* (2012b), where a degree of mean temperature means an increase of susceptible in 8894 cases.

**Table 1.** ARIMA Model obtained.

	Estimates	Standard Error	t	Sig
Non-Seasonal Lags AR1	.429	.165	2.603	.014
Regression Coefficients LAG1TM	8894.290	1674.033	5.313	.000

A Kalman filtering algorithm was used for estimation. AR1 Parameter Autoregressive of order 1. LAG1TM = Mean Temperature.

The behavior of the real value was analyzed and predicted (Fig 5), the pattern showed that the correlation is of 0.52 and with a value of significance of 99%.

This is interpreted as the real value and the predicted either coincides in increase or decrease in 52.4% and this is evidenced with 99% significance.

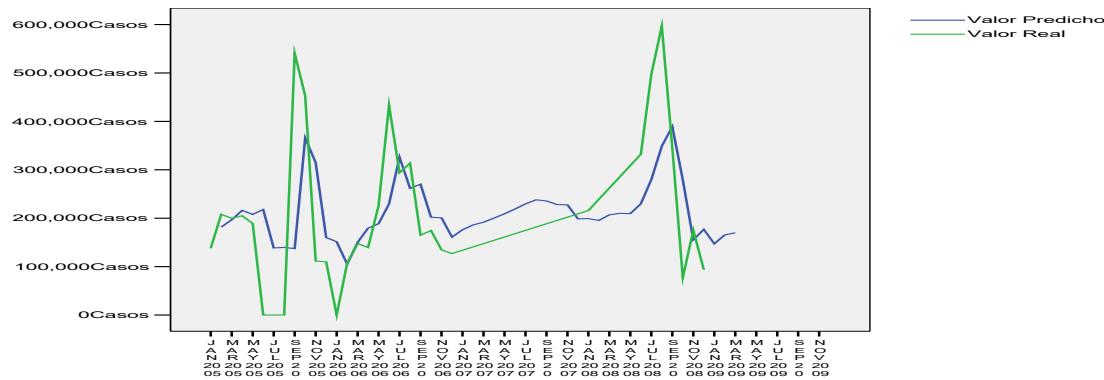


Figure 5. Behavior of the Susceptibility with regard to the Predicted value (=Valor Predicho) and Real in Villa Clara, Cuba.

Correlations between the total of deaths and the total of susceptible, being observed a positive correlation ( $r=0.39$ ,  $p=0.02$ ). Total deaths with temperature mean have not correlation with mean temperature ( $r=-0.02$ ,  $p=0.87$ ), but total of susceptible with mean temperature is positive correlated ( $r=0.40$ ;  $p=0.02$ ). Thus, it is predicted the total of deaths with regard to the susceptible ones that in turn depend of temperature (Tables 2 and 3) (Nicholson *et al.*, 2003; Si *et al.*, 2013; Jaakkola *et al.*, 2014).

According to the parameters of the pattern, it can be expressed that as the susceptible ones increase in 1000, the deaths ascend in 6 birds; thus, the total of susceptible for 0.06 will be the same approximately to the total of deaths.

Accordingly to the previous analysis it can be concluded that the final pattern has the following form: Total of deaths  $t = 0.002574 * \text{Susceptibility} -1 + 53.37 \text{ TM} -1 + 0.006 * \text{et}$ . ( $t = 4.46$ ;  $p = 0.00$ ). Where: et: it is the error that is made when predicting the Susceptibility at one time certain t. Susceptibility -1: it is the Susceptibility in the previous month. TM-1: it is the provincial medium temperature in the previous month.

Therefore, it can be appreciated that a degree of temperature means an increase of 53.37 deaths, thus, when temperatures of 30 °C are presented, it can be expected an increase of deaths of 1601 birds, this belongs together with that outlined in the Anonymous (2009), where it is expressed the complications and deaths by breathing dysfunctions in the increments of temperature. The values averages of the monthly

temperatures were analyzed in the period 2005-2007, then, it can be appreciated that in the three years the temperatures stockings of the warm months oscillate among the 26-27°C and more; as well as the high one averages yearly of the humidity 81-82%. In this aspect it coincides with that outlined by North & Bell (1990) that starting from the 27°C, the birds begin to suffer of caloric stress, as rising the susceptibility and deaths increase in birds due to the presence of the illness (Blackall, 1999; WHO, 2002; Shaman *et al.*, 2010).

In our paper no significant correlation was found with the relative humidity with the susceptibility, this coincide with Zhang *et al.* (2015) in which the relative humidity do not influence in the appearance of the virus on influenza A (H7N9), the humidity is usually regarded as a factor impacting on the transmission of diseases, that are transmitted by droplets or aerosols according to Koep *et al.* (2013) and Jaakkola *et al.* (2014). Our results can impact the poultry market reducing the number of cases of H7N9, this coincide with Xu *et al.* (2013) and with Yu *et al.* (2014). We coincide with Tsuchihashi *et al.* (2011), Herrick *et al.* (2013), and Zhang *et al.* (2015), because temperature influences the high risk of infection.

It was obtained that with 1°C of monthly mean temperature can be expected an increase of 8894 susceptible cases. As the susceptible ones increase in 1000, the deaths are increased in 6 birds; thus, the susceptible ones for 0.06 will be the same approximately to the total of deaths. The final ARIMA modeling expressed that an increase of 1 degree of temperature means an increase of 53.37 deaths.

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