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The Epidemiology of Guinea Worm Infection in Tamale District, in the Northern Region of Ghana

I.A. Adetunde
Department of Applied Mathematics and Computer Science,
Faculty of Applied Sciences, University for Development Studies, Ghaana, Nigeria

Abstract: A study was conducted in seven communities in Tamale to investigate the current pattern of prevalence and intensity of Dracunculiasis (Guinea worm) disease in the northern region of Ghana. The data were obtained from the Parasitic Disease Research Centre (PDRC). The main centre that is responsible for the collection of the monthly data on guinea worm infection. SAS was used to analysis the data and PROC AUTOREG was employed for fitting the model. It was observed that the number of guinea worm infection cases reduces with respect to time, indicating that what Diseases Control and Prevention (CDC) are saying will be accomplished that is the guinea worm disease will be completely eradicated.

Key words: Dracunculiasis, guineaworm, SAS, autoregression, autocorrelation, forecasting

INTRODUCTION

Guinea worm's Latin name is dracunculiasis or affliction with little dragons" but in Africa is often called "empty granary" because of its tendency to erupt at harvest time rendering farmers unable to work. Dracunculiasis is an infection cased by the nematode Dracunculus medinensis also known as the guinea fire worm that includes the filariae wuchereria bancrofti, Brugia malayi and Loaloa (Adewole *et al*., 1997; Donald and McNeil, 2006).

During the last twenty five years, concerted efforts to eradicate the guinea worm have been undertaken and these have revolved in a reduction of more than ninety nine percent of worldwide cases of dracunculiasis. Current disease incidence is low and is limited especially to Sub-Saharan Africa. The centers for disease Control and Prevention (CDC) proposed a global campaign for eradication of dracunculiasis in 1980 and in 1988, a number of African ministers of health set a target date of 1995 for total eradication. Although several factors have prevented accomplishment of this goal, the CDC now projects that the disease may be completely eliminated by 2009. This will mark an important epidemiologic medical accomplishment, as well as the end of a fascinating organism (CDC, 1990; CDC, 1990).

Through the efforts to control guinea worm, the Atlanta based carter centre in partnership with the office of Global health at the US centers for Disease control and Prevention (CDC), has played a role in stimulating community health change within Guinea-worm infected area in Ghana. The Carter Centers efforts took a new turn. The center is currently working with the Ghana Red Cross Women's Club to reduce level infection by working with male volunteers within rural villages to keep infected persons out of the water, using a simple cloth or nylon filter to remove the water flea from drinking water, treating ponds with larvicides, educating community members to promote behaviour change and providing site water sources. In 1999, female volunteer in 393 villages conducted door to door surveillance of Guinea worm, distributing filters, identifying potential water sources, ensuring the women did not enter infested waters and providing other community members with information (WHO, 2004).

STATEMENT OF THE PROBLEM

According to International Notes Updates (1991). Efforts to eradicate dracunculiasis began in 1981 immediately before the start of the international drinking water supply and sanitation decade. WHO has promoted the eradication campaign, which focuses on interruption of transmission of the disease, surveillance of new cases and certification of eradication. Specific interventions include: health education, case containment, community base surveillance systems, provision of sale water, including use of filtering devices and chemical treatment of water sources with all these efforts, this paper looked into the epemiology of guinea worm infection in Tamale district in the northern region of Ghana and to see to rate

of reduction with its eradication. Ghana and Nigeria established Guinea Worm Eradication Programmes. (GWEPs) in December 1987 and May 1988, respectively of the 17 countries in Africa with endemic dracunculiasis, Ghana and Nigeria have the highest known prevalence of the disease. Consequently, therefore, the need arises as to assess the epidemiology of guinea worm infection in Tamale district, in the northern region of Ghana.

Objectives of the study: The major objectives of this research study are:

- To identify fluctuations in the seasonal, secular and cyclical variations in the infection of Guinea Worm Disease.
- To find a suitable model to represent the infection of the Guinea Worm Disease in the district.
- To forecast future results from past values.

MATERIALS AND METHODS

Study area: The study was conducted in Tamale district in Northern Region of Ghana, which is made up of mainly peasant farmers. The district is located on latitude 9°N and longitude 1° west. It shares common boundaries with Savelugu/Nanton, Tolon/Kumbungu and Yedi, East, West and Central Gonga district, respectively. This district is poorly endowed with water bodies. The only water system is few seasonal streams which have water during the rainy season and dry up during the dry season. Tamale is located in the Guinea-Savannah belt, which experience only one raining season starting from April/May to September/October with a peak season in July/August. It has the annual rainfall of 1100mm with only 95 days of intensive rainfall. The dry season is normally from November to March which comes under the influence of the dry-North-Easterly (Harmattan) winds, while the rainy season is influence by the moist South-Westerly winds. Maximum day temperature ranges from 33-39°C while minimum night temperature ranges from 20-22°C the mean annually day sunshine is approximately 7.5 h.

Data collection: Data were obtained from the parasitic Disease Research Centre (PDRC) in Tamale who went round the communities in Tamale district to collect the monthly data on the guinea worm infection. The Table 1 shows the guinea worm infection cases for the 2001-2006.

RESULTS AND DISCUSSION

SAS was used to analysis the data with the procedure called PROC-AUTOREG, for finding the model (Table 2-6).

- The SAS System.
- The AUTOREG Procedure.
- Dependent Variable Y.

The appropriate time series model can be written as $Y_t = E(y_t) + R_t$

Where the long-term trend, $E(y_t)$ is given by $E(y_t) = \beta_0 + \beta_1 t$ and the auto correlated residuals, R_t are represented by the auto regressive model.

$$R_t = \phi R_{t-1} + \epsilon_t$$

Combing the two component into one model gives

$$y_t = \beta_0 + \beta_1 {}^{tt} R_{t-1} + \epsilon$$

From the SAS AUTO REG printout the estimate of the first order autoregressive parameter ϕ is-0.955.

However, SAS autoregressive model is defined so that ϕ has the opposite sign from the value contained in the model.

As a result we multiply the estimate of ϕ shown in the SAS AUTOREG printout by-1. Therefore, we have $\hat{\phi} = (-0.955)(-1) = 0.955$. Also from the printout $\hat{\beta}_0 = 36.44$ and $\hat{\beta}_1 = 0.00127$ the fitted time series model now becomes

$$\hat{y}_t = 36.44 + 0.00127t + 0.955\hat{R}_{t-1}$$

The value of $\hat{\beta}_1$ is positive and significant at $\alpha = 0.01$ the value of $\hat{\phi} = 0.955$ is also positive implying that the time series are positively correlated. The auto regressive component in the model accounts for the possible residual autocorrelation.

Table 1: Guinea Worm Infection cases for 2001-2006

Year	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC	Total
2001	35	54	39	39	21	10	7	4	5	7	30	12	255
2002	17	25	57	79	36	44	21	10	4	7	35	65	410
2003	98	282	170	102	26	49	17	11	7	8	8	7	785
2004	42	109	63	93	58	16	7	3	1	3	3	7	405
2005	25	34	36	38	33	25	10	0	1	10	20	20	252
2006	95	81	71	34	33	17	11	8	5	9	13	84	461

Table 2: Ordinary least squares estimate

SSE		30961.9678	DFE	70
MSE		442.31383	Root MSE	21.03126
SBC		649.477592	AIC	644.92426
Regress R-Square		0.0044	Total R-Square	0.0044
Durbin-Watson		0.0054		

Variable	DF	Estimate	Standard Error	t value	Approx Pr > |t|
Intercept	1	37.6236	3.2013	11.75	<.0001
T	1	-0.0315	0.0568	-0.55	0.5810

Table 3: Estimates of autocorrelations

Lag	Covariance	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
0	430.0	1.000000	]*******************]
1	410.6	0.954803	]*******************]

Preliminary MSE37.9934

Table 4: Estimates of autoregressive parameters

Lag	Coefficient	Standard errort	T-value
1	-0.954803	0.035783	-26.68

Table 5: Yule-walker estimates

SSE	239.943783	DFE	69
MSE	3.47745	Root MSE	1.86479
SBC	306.252758	AIC	299.422759
Regress r-square	0.0006	Total r-square	0.9923
Durbin-watson	0.8758		

Table 6: The autoreg procedure

Variable	DF	Estimate	Standard error	t-value	Approx Pr > |t|
Intercept	1	36.4436	3.8700	9.42	<.0001
T	1	0.001268	0.006246	0.20	0.8397

Hence, the Mean Square Error (MSE) = 3.477, the estimate of δ is then Root MSE = 1.8647. Thus, we expect to predict the monthly guinea worm infection cases to within $2\delta = 2(1.8647)$.

FORECASTING

The fitted model is given by.

$$\hat{y}_t = 36.44 + 0.00127t + 0.955\hat{R}_{t-1}$$

Now let us consider first, the forecast for January 2007 (t = 73).

Substituting t = 73 into the estimated model we have

$$\hat{y}_{73} = 36.44 + 0.00127\,(73) + 0.955\ \hat{R}_{72}\,.$$

To complete the calculation for the forecast, we require n estimate of the residual for 2006.

By definition, the residual in year t is equal to the difference between the observed GWI in year t and its corresponding predicted value.

Thus

$$\hat{R}_t = y_t - \hat{y}_t,$$

t represents time.

$$\hat{R}_t = y_t\text{-}(36.44 + 0.00127(t.)$$

Substituting t = 72 into the above, we obtain

$$\hat{R}_t = y_t\text{-}(36.44 + 0.00127(72)$$

But y_{72} is number of guinea worm infection cases is December, 2006.

$Y_{72} = 84$

$$\hat{R}_{72} = 84\text{-}(36.44+0.00127(72))$$

= 47 .468

The forecast for Jan 2007 is

$$\hat{y}_{73} = 36.44+0.00127(73) + 0.955(47\text{-}468)$$

= 81.867

= 82(rounded)

Thus 82 cases of guinea worm infection will be recorded in the district.

The forecast for Feb. 2007 (t = 74)

$$\hat{y}_t = 36.44+0.00127t + 0.955\ \hat{R}_{t-1}$$

$$\hat{y}_{74} = 36.44+0.00127(74) + 0.955\ \hat{R}_{73}$$

$$\hat{R}_{73} = y_{73}\text{-}(36.44+0.00127(73))$$

y_{73} is the total number of guinea worm infection cases recorded in January 2007

$$\text{Thus } y_{73} = \hat{y}_{73} = 82$$

$$\hat{R}_{73} = 82\text{-}(36.44=0.00127(73))$$

$$= 45.467$$

$$\hat{y}_{74} = 36.44+0.00127(74)+0.955(45.467)$$

$$= 79.95$$

$$= 80(\text{rounded})$$

Thus 80 cases of guinea worm infection will be recorded in Feb 2007.

The approximate 95% forecasting limit using

Time series model with first-order Autoregressive Residuals.

For the one-step ahead forecast Y_{n+1} (this the GWI forecast for January, 2007) the 95% prediction interval is given by:

$$\hat{y}_{n+1} \pm \sqrt{MSE}$$
$$\sqrt{MSE} = 1.8647$$
$$n = 72.$$
$$\hat{Y}_{73} \pm 2(1.8647)$$
$$\Rightarrow 82 \pm 2(1.8647) \text{ OR } (78.27, 85.73)$$

Where n is the total number of observations
For the two step-ahead forecast
Y_{n+2} (thus the GWI for February 2007)
The prediction interval is given by

$$\hat{y}_{n+2} \pm 2\sqrt{MSE(1+\hat{\phi}^2)}$$
$$MSE = 3.477 \text{ and } \hat{\phi} = 0.955$$
The approximate 95% prediction interval is
$$\hat{y}_{74} \pm 2\sqrt{3.477(1+0.955)^2}$$
$$80 \pm 5.1567 \text{ or}$$
$$(74.48, .85.156)$$

From the printout $R^2 = 0.9923$ indicating the 99.2% of the model accounts for the sample variation in the GWI data.

The Durbin Watson d statistic from the printout is 0.8756 which is less than 2 indicating that residuals are positively auto correlated.

From the results above the number of guinea worm infection cases for the first forecast is 82 and that of the second forecast is 80.

It can be seen clearly that there has been a reduction of 2 cases of guinea worm infection from December 2006 to January 2007 and also a reduction of 2 cases from January to February 2007 as shown in the forecasted values.

The approximate 95% prediction interval for the first forecast is (78.27, 85.73) and that of the second forecast is (74.48, 85.16). This gives the reliability of the forecasted values.

The reduction in the number of guinea worm infection cases could be as a result of the effort made by the humanitarian and health organizations like Centers for Disease Control and Prevention (CDC) and the Atlanta-based Carter Center who have male and female volunteers within the District who help reduce the local infection of the disease by keeping infected people out of the water source, treating ponds or dams with larvicides such as Abate, educating members of the District to use nylon filters to remove water flea from the drinking water, educating people in the District to promote behavior change and providing safe water sources.

CONCLUSION

From the analysis it was observed that the number of guinea worm infection cases reduces with respect to time. If this trend should continue then there is likelihood that the guinea worm disease will be completely eradicated from the district as projected by center for disease control and prevention (CDC).

If efforts been put in place by WHO, CDC, GWEPs are strictly adhere to Guinea worm diseases will be completely eradicated. Evidence have shown from the research that with time, it will be eradicated completely, because there is a drastically reduction in guinea worm infection in Tamale district, in the northern region of Ghana.

SUGGESTED WAYS OF CONTROLING PROCEDURES

The District Assembly together with the Government should make provision for the supply of portable drinking water to entire people in the District and have existing dysfunctional bore holes repaired.

Also more educational programmes should be organized to educate the entire district so as to completely eradicate the disease. The people in the District should continue practicing the preventive measures such as Monique (2004) and Hopkins *et al.* (1995):

- Drink only water from underground sources free from contamination, such as a borehole or hand-dug wells.
- Prevent persons with an open Guinea Worm ulcer from entering ponds and wells used for drinking water.
- Always filter drinking water, using a cloth filter, to remove the water fleas.
- Additionally, unsafe sources of drinking water should be treated with an approved larvicide such as Abate, that kills water fleas.
- Areas with known outbreaks or more frequent infections must be identified and equipments must be made available to clear drinking water in those places.

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