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MALE URETHRAL DISCHARGE CASES AT GWERU PROVINCIAL HOSPITAL IN ZIMBABWE: EMPIRICAL EVIDENCE FROM A BOX-JENKINS "CATCH ALL" MODEL

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ABSTRACT:

In this research paper, the SARIMA model has been used to model and forecast Urethral Discharge in Men (UDM) at Gweru Provincial Hospital (GPH) in Zimbabwe. The study covers the period January 2010 to December 2019. The out-of-sample forecasts range over the period January 2020 to December 2021. The residual analysis of the SARIMA model shows that the model applied in this study is quite stable and suitable for forecasting UDM at GPH. The forecasts show a generally upwards trajectory of UDM cases at GPH over the period January 2020 – December 2021, characterized by seasonal peaks in December of each year. The paper offers a three-fold policy recommendation for use by the GPH health executive.

INTRODUCTION:

Sexually Transmitted Infections (STIs) are among the world's common diseases, with an annual incidence exceeded only by diarrheal diseases, malaria, and lower respiratory infections. The burden on the health care system and health care expenditure is great. STIs, even without including HIV, are consistently among the most common conditions leading to health care visits regardless of national resources. Due to their high prevalence, especially in developing country settings, STIs result in substantial productivity losses for individuals and communities, particulary where the majority of the population is below 40 years of age (CDC, 2008). The commonest causes of urethral discharge are Neisseria gonorrhea and chlamydia trachomatis and the two often co-exist. Trichomonas vaginalis causes a urethral discharge in men (UDM) (EDLIZ, 2015). In Zimbabwe, men presenting with urethral discharge, Neisseria gonorrhoeae and Chlamydia trachomatis are the most commonly associated pathogens (Reitmeijer et al., 2018). All males with urethral discharge should be treated for both gonorrhea and chlamydia in view of the fact that the two coexist and present with similar symptoms and signs (EDLIZ, 2015). This paper looks at urethral discharge in men admitted at Gweru Provincial Hospital (GPH) during the period January 2010 – December 2019.

1 OBJECTIVES OF THE STUDY:

i. To examine UDM at GPH over the period January 2010 to December 2019.
ii. To predict UDM for GPH over the period January 2020 to December 2021.
iii. To assess whether UDM is increasing or decreasing for CCH over the out of sample period.

LITERATURE REVIEW:

In Zambia, Makasa (2012) investigated the epidemiological context of sexually transmitted infections using data from various surveys and laboratory tests and found out that there was an overall decline in syphilis trends between 1994 and 2008 among urban and rural women in Zambia. Mungati et al. (2018) carried out an etiology of GUD in Zimbabwe using data from six geographically diverse clinics and found out that the herpes simplex virus was the leading cause of GUD. Reitmeijer et al. (2018) examined the current etiology of urethral discharge and other STIs in Zimbabwe and found out that among men presenting at Zimbabwe STI clinics with urethral discharge, Neisseria gonorrhoeae and Chlamydia trachomatis are the most commonly associated pathogens. Lowe et al. (2019) sought to determine the prevalence and associated risk factors for STI coinfection in a cohort of HIV-infected women using a logistic regression approach and concluded that a high prevalence of predominantly asymptomatic STIs was reported in HIV-infected women. The study also found out that more than three lifetime sexual partners and less formal education are risk factors for coinfection with non-viral STI. Nyoni & Nyoni (2020), in a most recent study, applied ANN models in forecasting GUD for Chitungwiza urban district based on a data set covering the period January 2012 to December 2018 and concluded that GUD cases for both males and females have been shown to decrease in Chitungwiza urban district. No study has been done in Zimbabwe, to model and forecast UDM cases, and yet such studies are essential in the control of the spread of UDM, other STIs as well as HIV.

METHODOLOGY:

This study will apply the Box-Jenkins SARIMA model in analyzing UDM cases at GPH. The Box-Jenkins SARIMA model, in its simplest form, can be expressed as follows:

$$\phi_p(B)\emptyset_p(B^s)UDM_t = \theta_q(B)\Theta_q(B^s)\varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

Where B is the backshift operator, $\phi_p, \emptyset_p, \theta_q$ and Θ_q are polynomials of order p, P, q and Q respectively. ε_t is a white noise process and $UDM_t = \nabla_d \Delta_s^D Y_t$ is the differenced R series.

1 DATA:

This study is based on monthly observations of new Urethral Discharge in Men (UDM) aged 15 to 49, who have been managed at Gweru Provincial Hospital (GPH), from January 2010 to December 2019. The out-of-sample forecast ranges over the period January 2020 to December 2021. All the data employed in this study was gathered from GPH Health Information Department.

3.2 DIAGNOSTIC TESTS AND MODEL EVALUATION

Unit Root Tests: Graphical Analysis

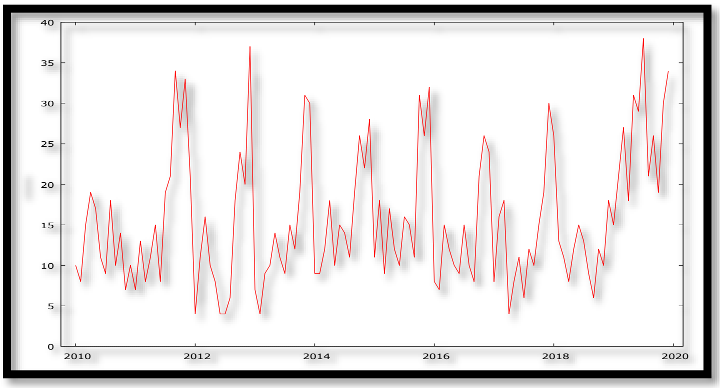


Figure 1: Graphical Analysis

Figure 1 shows that UDM series is basically trending upwards. This means that this series may not be stationary in levels. The Augmented-Dickey-Fuller (ADF) test will be employed to formally check for unit roots.

The ADF Test:

Table 1: Levels-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
UDM_t	-6.066086	0.0000	-3.486064	@1%	Stationary
			-2.885863	@5%	Stationary
			-2.579818	@10%	Stationary

Table 2: Levels-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
UDM_t	-6.277177	0.0000	-4.036983	@1%	Stationary
			-3.448021	@5%	Stationary
			-3.149135	@10%	Stationary

Table 3: without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
UDM_t	-1.486595	0.1278	-2.584707	@1%	Not stationary
			-1.943536	@5%	Not stationary
			-1.614927	@10%	Not stationary

Table 4: 1st Difference-intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
$D(UDM_t)$	-14.48784	0.0000	-3.486551	@1%	Stationary
			-2.886074	@5%	Stationary
			-2.579931	@10%	Stationary

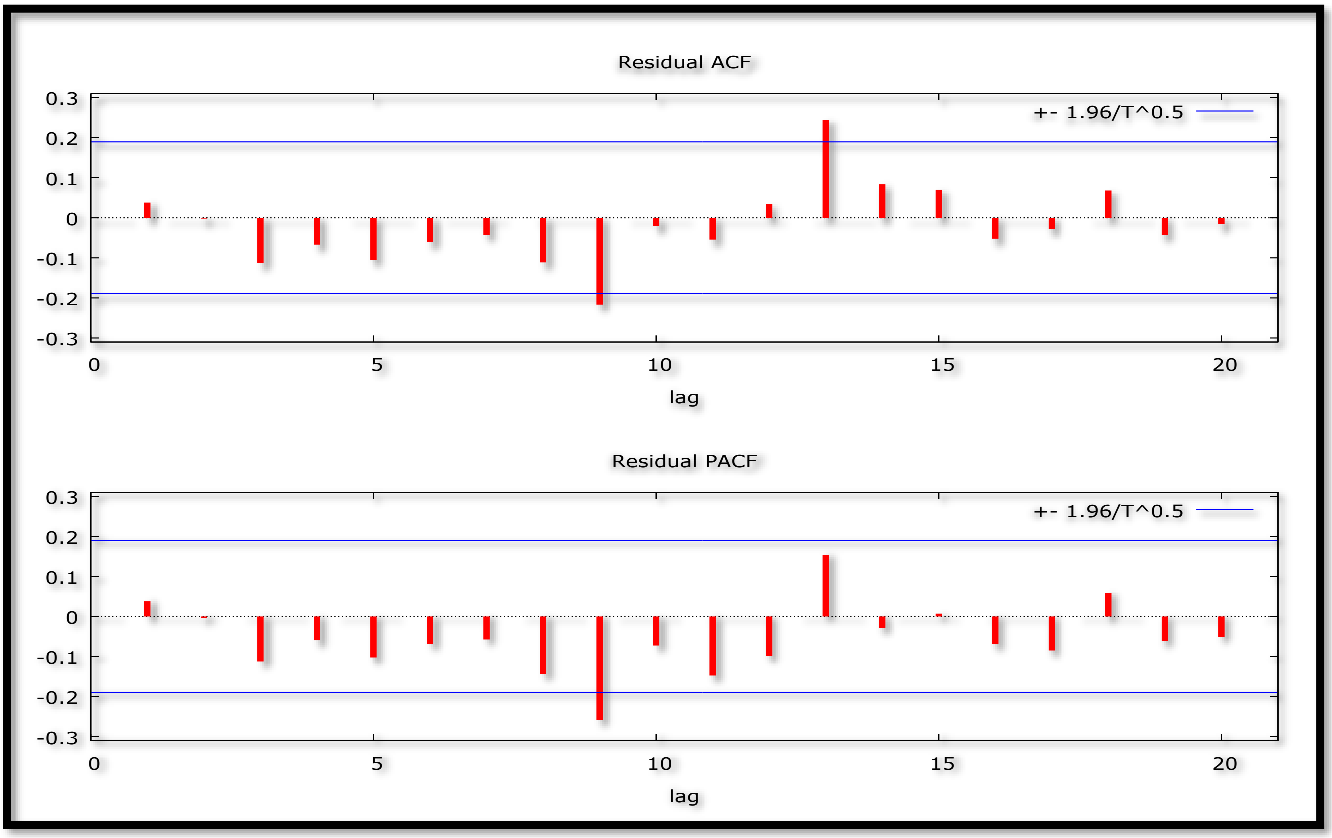
Table 5: 1st Difference-trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
$D(UDM_t)$	-14.43214	0.0000	-4.037668	@1%	Stationary
			-3.448348	@5%	Stationary
			-3.149326	@10%	Stationary

Table 6: 1st Difference-without intercept and trend & intercept

Variable	ADF Statistic	Probability	Critical Values		Conclusion
$D(UDM_t)$	-14.53689	0.0000	-2.584707	@1%	Stationary
			-1.943563	@5%	Stationary
			-1.614927	@10%	Stationary

Tables 1 – 6 basically indicate that UDM is an I(1) variable.



Analysis of the Residuals of the SARIMA (0, 1, 1)(0, 1, 1)$_{12}$ Model, Residual Correlogram of the SARIMA (0, 1, 1)(0, 1, 1)$_{12}$ Model, Figure 2: Residual Correlogram

Figure 2 indicates that the residuals of the Box-Jenkins "catch all" model applied in this paper are quite stable and this indicates that our predictive model is adequate.

RESULTS OF THE STUDY:

Descriptive Statistics:

Table 7: Summary Statistics, using the observations 2010:01 - 2019:12, for the variable UDM (120 valid observations)

Mean	Median	Minimum	Maximum
15.692	14.000	4.0000	38.000
Std. Dev.	C.V.	Skewness	Ex. kurtosis
8.1517	0.51949	0.84156	-0.12714

The average number of cases of UDM recorded over the study period is approximately 16 cases per month. The minimum number of UDM cases over the study period is 4 cases per month while the maximum number of cases is 38 cases per month.

Results Presentation

Table 8: Main Results of the SARIMA (0, 1, 1)(0, 1, 1)12 Model

The SARIMA (0, 1, 1)(0, 1, 1)$_{12}$ model can be presented as follows:

$$(1-B)(1-B^{12})UDM_t = (1-0.507590B)(1-0.67390B^{12})\varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

Variable	Coefficient	Standard Error	z	p-value
θ_q	-0.507590	0.0811076	-6.258	0.0000***
Θ_q	-0.673490	0.124206	-5.422	0.0000***

Forecast Graph:

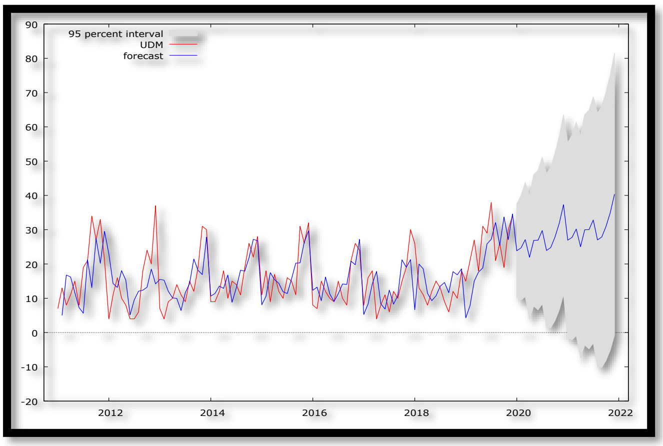
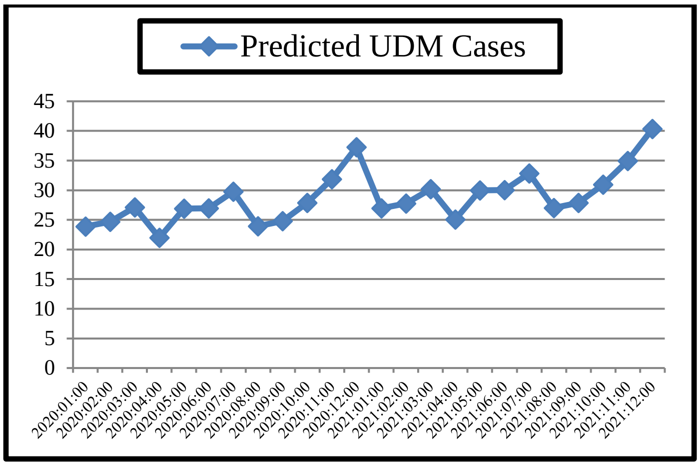


Figure 3: Forecast Graph

Out of Sample Forecasts

Table 9: Out-of-sample forecasts

Year: Month	Predicted UDM Cases	Standard Error	95% Confidence Interval
2020:01	23.8731	6.98316	(10.1864, 37.5599)
2020:02	24.6780	7.78385	(9.42192, 39.9341)
2020:03	27.1220	8.50954	(10.4436, 43.8004)
2020:04	21.9735	9.17802	(3.98488, 39.9621)
2020:05	26.9040	9.80101	(7.69435, 46.1136)
2020:06	26.9434	10.3867	(6.58580, 47.3009)
2020:07	29.7653	10.9411	(8.32118, 51.2095)
2020:08	23.9328	11.4687	(1.45451, 46.4110)
2020:09	24.7998	11.9731	(1.33295, 48.2667)
2020:10	27.8759	12.4571	(3.46046, 52.2913)
2020:11	31.8912	12.9230	(6.56264, 57.2197)
2020:12	37.2772	13.3726	(11.0673, 63.4870)
2021:01	26.9507	14.5441	(-1.55510, 55.4566)
2021:02	27.7556	15.2425	(-2.11923, 57.6304)
2021:03	30.1996	15.9104	(-0.984217, 61.3834)
2021:04	25.0511	16.5513	(-7.38891, 57.4911)
2021:05	29.9816	17.1683	(-3.66772, 63.6309)
2021:06	30.0210	17.7639	(-4.79568, 64.8377)
2021:07	32.8429	18.3402	(-3.10318, 68.7891)
2021:08	27.0104	18.8989	(-10.0308, 64.0516)
2021:09	27.8774	19.4416	(-10.2273, 65.9822)
2021:10	30.9535	19.9695	(-8.18591, 70.0930)
2021:11	34.9688	20.4838	(-5.17867, 75.1163)
2021:12	40.3548	20.9855	(-0.776013, 81.4856)



Graphical Presentation of the Predicted Monthly Urethral Discharge Cases at GPH (Out-of-Sample)

Figure 4: Graphical presentation of out-of-sample forecasts

The main results of the Box-Jenkins "catch all" model are shown in table 8 above. All the parameter estimates of the model are statistically significant at 1% level of significance. Figure 3 is a graphical representation of the in-sample and out-of-sample forecasts. Table 9 and figure 4 show out-of-sample forecasts only. From figure 4, it is clear that the projected UDM series is generally rising, characterised by seasonal repeats in December each year. It is reasonable to observe more UDM cases in December because during the December festive holidays most men tend to engage in more risky sexual behaviours as part of the so-called "enjoying".

Recommendations:

i. The only way to prevent UDM is abstinence. There is need for GPH to sensitize the need for abstinence in order to reduce UDM cases, especially in younger men, particulary those who are not yet married.
ii. GPH's sexual health education programmes, in the community, must be more frequent just before festive December holidays in order to induce desired sexual behaviour change. In this regard, there is need to continuously promote correct and consistent use of condoms and VMMC (Voluntary Medical Male Circumcision), especially, for adult males. Furthermore, there is need for GPH to strengthen sexual reproductive health and HIV programme linkages so that UDM cases are tested for HIV and given ART if they are HIV positive.
iii. Men ought to be encouraged to seek healthcare in order to enhance early detection and treatment of STIs and subsequently prevent complications.

CONCLUSION:

UDM is one of the fundamental risk factors in the transmission of HIV. At GPH, the study has shown that UDM cases peak in December of each year. These results are not surprising given that men in developing countries such as Zimbabwe lack adequate sexual health education and also have a poor healthcare seeking behaviour. The applied SARIMA $(0, 1, 1)(0, 1, 1)_{12}$ has been shown to be stable and suitable for forecasting UDM cases at GPH. This study, being the first study to forecast UDM cases in Zimbabwe, will go a long way in improving existing STI policy frameworks not only at GPH but also for the whole country at large, especially with regards to modelling and forecasting STIs. Further studies may look into analyzing UDM prevalence and its risk factors using a SARIMAX model: that can potentially produce interesting results especially if the study is done at a quaternary level referral hospital.

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